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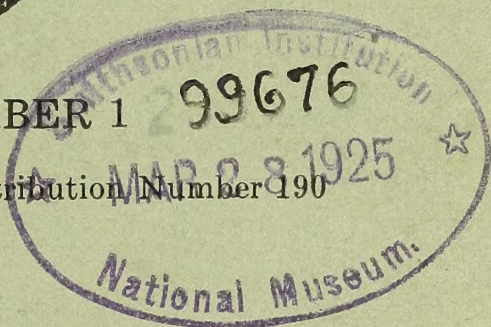
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KARTABO, BRITISH GUIANA



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STUDIES OF A TROPICAL JUNGLE

ONE QUARTER OF A SQUARE MILE OF JUNGLE
AT KARTABO, BRITISH GUIANA

BY WILLIAM BEEBE

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STUDIES OF A TROPICAL JUNGLE

INTRODUCTION

BY HENRY FAIRFIELD OSBORN

The British Guiana Kartabo Station of the Department of Tropical Research of the New York Zoological Society was founded in January, 1916, after many conferences of Henry Fairfield Osborn, Theodore Roosevelt, Madison Grant and William Beebe. The site chosen was the district immediately around Bartica, British Guiana, in typical tropical rain forest, sixty-five miles from the coast and at an elevation of only twenty-five feet. The Station itself is at Kartabo, at the point of junction of the Cuyuni and Mazaruni Rivers, where intensive research work has been carried on in a quarter of a square mile of jungle and shore.

Under the directorship of William Beebe, five expeditions have been made into this field. There have been thirty-six months of actual work, covering every season of the year. Research work at the Station has been carried on by thirty-three workers from America, England, Scotland and France, and three hundred and six visitors have been entertained. One hundred and fifty contributions have been published, including five bound volumes.

From the limited area under intensive investigation there have been collected notes, materials and specimens as follows:

- (1) Life history notes on 73 species of mammals, 464 species of birds, 130 species of reptiles and amphibians, and 150 species of fish.
- (2) Nests, eggs or breeding records of 206 species of birds, many new to science.
- (3) Skins, skulls and skeletons of 60 species and 750 individual mammals.
- (4) 1738 bird skins.
- (5) 126 bird embryos.
- (6) Hundreds of specimens of reptiles, amphibians and fish.

- (7) 85,000 insects, of which one item alone is the types of eighty-seven new species of termites.
- (9) 4,000 other invertebrates.
- (10) 550 KOH specimens.
- (11) 3000 photographic negatives.
- (12) 22,000 feet of motion picture film.
- (13) Specimens have been supplied to eight universities and five museums, while of living vertebrates there have been collected and sent to the New York Zoological Park 45 mammals, 215 birds, and 125 reptiles.
- (14) The chief collections of amphibians, reptiles, mammals and many invertebrates have been presented to the American Museum of Natural History.

It is interesting, in view of this successful prosecution of research work in the tropics, to consider the actual cost of the entire undertaking. From the beginning to the year 1924 the total income has been \$49,600. This has included the salary of the director, his assistant and chief artist, the steamship fares, entire scientific outfit, boats, tents, bungalow, household expenses, servants, hunters, taxidermists and the general accommodation for the staff of workers. The five expeditions have averaged six and a half months each, with an average of eight staff workers, the total average cost of each trip being \$9,920.

OUTLINE

I—GEOGRAPHICAL POSITION

- 1 Latitude and Longitude
- 2 Country, Rivers

II—METEOROLOGY

- 1 Seasons
- 2 Rainfall
- 3 Humidity
- 4 Sunshine
- 5 Temperature
- 6 Wind
- 7 Comparison with Coast and Interior

III—GEOLOGY

- 1 Rocks, Minerals and Soil
- 2 Earthquakes

IV—PHYSICAL CHARACTER

- 1 Land: Altitude, levels, swamps
- 2 Tidal area and shore
- 3 Water: creeks, rivers, tides

V—FLORA

- 1 Aquatic
- 2 Littoral
- 3 Jungle
- 4 Clearing

VI—FAUNA

- 1 Protozoa
- 2 Porifera
- 3 Coelenterata
- 4 Platyhelminthes
- 5 Nematelminthes
- 6 Trochelminthes
- 7 Molluscoida
- 8 (Echinodermata)
- 9 Annulata
- 10 Mollusca
- 11 Arthropoda
- 12 Chordata

VII—HISTORICAL

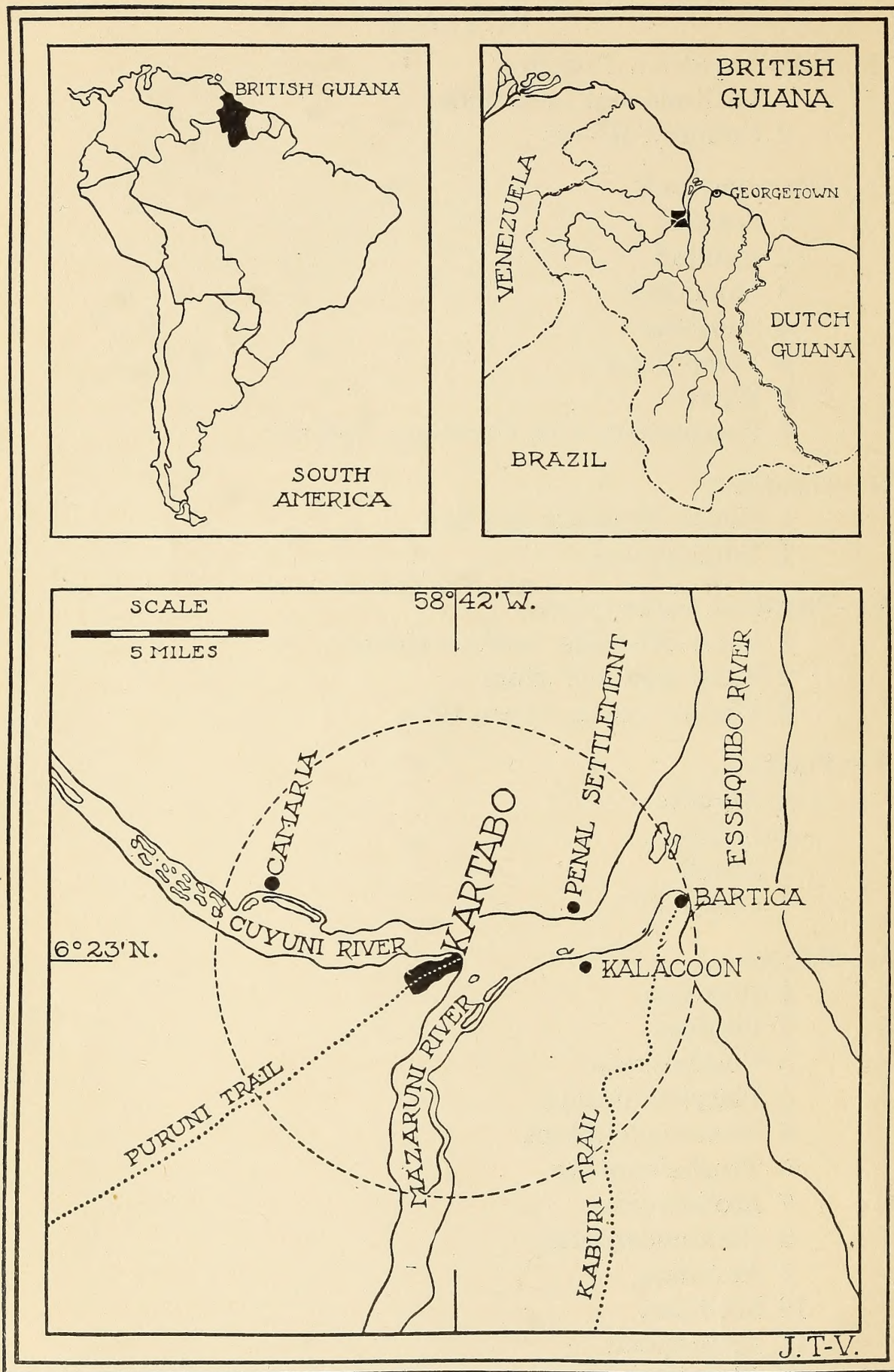


Plate A. British Guiana Tropical Research Station of the New York Zoological Society.
The circle represents a radius of six miles.

STUDIES OF A TROPICAL JUNGLE;¹ ONE QUARTER OF A SQUARE MILE OF JUNGLE AT KARTABO, BRITISH GUIANA

BY WILLIAM BEEBE

(Plates A, B. Figs. 1-17 incl.)

This study of the environment or ecology of Kartabo is offered as a general survey of the region. Every fact in it is as true and correct as I can make it, but all estimates are underestimates. For example, the number of species of amphibians represents probably three-fourths of the actual autochthonous fauna; the mammals observed could certainly in time be increased by twenty-five per cent., and so on. This is in spite of the fact that several of us have spent five seasons of work here, but even in this limited area, the life of the opaque waters, and that under ground, in the lofty treetops and of the night must still hide innumerable forms from us.

This entire contribution outlines the more interesting and significant points of view which have presented themselves while I have been engaged in more specific, definite researches. It is intended as an introduction to the faunal papers which will follow in succeeding numbers of *Zoologica*.

I—GEOGRAPHICAL POSITION

British Guiana, on the north-east coast of South America, is about twice as large as the State of New York. The Essequibo is the largest river of the Colony, and its most important tributary, entering at Bartica, is the Mazaruni. Six miles above this point, the Cuyuni joins the Mazaruni, and at the exact meeting point is Kartabo, the site of the Tropical Research Station of the New York Zoological Society.

The Cuyuni winds for two hundred and fifty miles in a general north-west direction and rises somewhere in the wilderness heart of Venezuela; the Mazaruni, through one of its tributaries, twists and turns through an equal distance of gold and diamond country, and drains the very slopes of the mighty plateau of Roraima, on the Brazilian frontier.

Kartabo, then, is in the north-central part of British Guiana, and its position relative to the three great rivers is such that its exact location is indicated on even the smallest of continental maps. Its position on the earth's surface is 58° 42' West Longitude, and 6° 23' North Latitude.

¹ Contribution, Department of Tropical Research No. 190



Fig. 1. Orientation Map of Kartabo.
Drawing by John Tee-Van.

The following distance lines of radiation may prove an additional help in the orientation of Kartabo:

The Atlantic Ocean is forty-five miles NNE.

The Dutch Guiana frontier is 120 miles SE.

The Equator is 400 miles S.

Kaieteur Falls are 100 miles SSW.

The Brazilian frontier is 128 miles WSW.

The plateau of Roraima is 160 miles WSW.

The Venezuelan frontier is 121 miles WNW.

New York City is 2200 miles NNW.

As may be seen by the accompanying map, a circle with a six mile radius from Kartabo includes Bartica and the banks of the Essequibo, together with the Mazaruni and the Cuyuni up to their first falls and rapids.

The general research work has been carried on within the black area at Kartabo. *Unless otherwise stated, the following account of this region, and the various articles which will follow in future numbers of Zoologica, dealing with more definite, intensive researches, refer altogether to this tract of land and water, measuring less than two thousand by four thousand feet, at the very point of juncture of the Cuyuni and Mazaruni Rivers—an area one-quarter the size of Central Park in New York City, or, to use a less local simile, a square of land measuring ten average city blocks on each of the four sides.*

This limited field of intensive research is the most important factor in the work carried on at the Station, and presents tropical abundance of life with a vividness which transcends any generalizations or statements based on less definite grounds.

II—METEOROLOGICAL CONDITIONS

Kartabo, British Guiana

Introduction

Accurate records of weather conditions have been kept for many years at His Majesty's Penal Settlement, three miles N. E. by E. from Kartabo, on the north shore of the Mazaruni River, the station being fitted up as a Normal Climatological Station of the Second Order of the International Classification. Records of rainfall are taken at The Hills Plantation, three-quarters of a mile from Kala-coon, the first home of the Tropical Research Station. The Hills Plantation is situated on the south shore of the Mazaruni River, directly opposite the Penal Settlement.

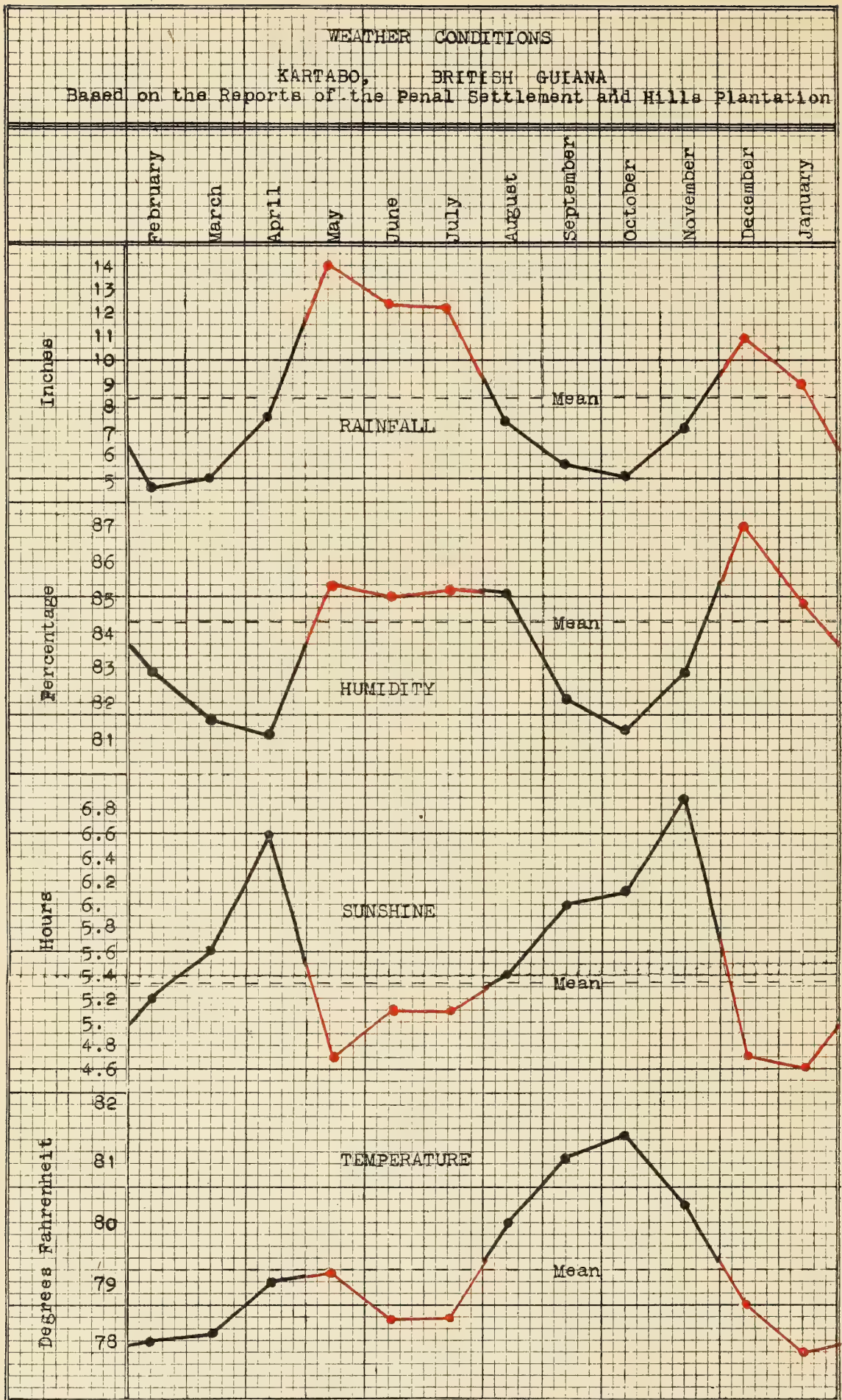


Fig. 2. Variations of weather conditions, Kartabo, British Guiana.

Thus, the two stations, Penal Settlement and The Hills Plan-tation, form the base of the triangle of which Kartabo is the apex. Both places are approximately three miles down river from the Station at Kartabo, and are separated from each other by about three-quarters of a mile.

The reports of these two stations may be taken as representing the weather conditions of Kartabo, and the immediate vicinity, some records extending back twenty years. The following state-ments and charts are entirely based upon the published and un-published records of observations of these climatological stations.

Seasons

Although the beginning and ending of the seasons cannot be stated in exact terms of weeks or days, the following four divisions are recognized as distinct:—

- Short Dry Season—February, March, April.
- Long Wet Season—May, June, July.
- Long Dry Season—August, September, October, November.
- Short Wet Season—December, January.

Adopting these seasons, the rainfall in inches and percentage is given in the following tables:—

Seasons			
Number of Inches and Percentage of Yearly Rainfall			
Short Dry Season	17.05 Inches	16.8	per cent.
Long Wet Season	38.84 “	38.4	“ “
Long Dry Season	25.27 “	25.2	“ “
Short Wet Season	19.81 “	19.6	“ “

Adding the rainy and dry seasons together as single seasons we have the following figures:—

Rainy Seasons	58.65 Inches	58.0	per cent.
Dry Seasons	42.32 “	42.0	“ “

Roughly speaking, three-fifths of the rains are to be found distributed through the five months assigned to the rainy seasons, and the other two-fifths to the seven months of the dry seasons.

This gives an average of 6.04 inches rainfall for the dry months, and 11.73 inches for the wet months.

Rainfall

The average annual rainfall is 100.53 inches. The months average as follows:—

February.....	4.55 inches
March.....	4.94 “
April.....	7.56 “
May.....	14.00 “
June.....	12.44 “
July.....	12.40 “
August.....	7.40 “
September.....	5.56 “
October.....	5.19 “
November.....	7.11 “
December.....	10.93 “
January.....	8.87 “

The list of months given their position according to greatest rainfall becomes:—

May	April
June	August
July	November
December	September
January	October
	March
	February

The available data, as to the number of days upon which rain falls, show an annual average of two hundred and nineteen days or fifty-nine per cent. of the whole year.

During 1920, May and June each had twenty-seven days upon which rain fell, while February, the lowest month, had six days. The highest recorded annual rainfall is 117.75 inches in 1918, and the lowest 77.11 inches in 1911. The highest rainfall for a single month was in May, 1918, 22.34 inches, and the lowest occurred during February, 1912, a year of drought, and was .03 inches.

Humidity

The available records for humidity show observations taken three times a day, at 7:00 A.M., 1:00 P.M. and 6:00 P.M.

The following table gives the mean of these observations:—

7:00 A.M.....	90.9	per cent.
1:00 P.M.....	79.0	“ “
6:00 P.M.....	82.2	“ “
Average.....	84.2	“ “

The following table gives the average of the humidity by months:—

February.....	82.9	per cent.
March.....	81.5	“ “
April.....	81.1	“ “
May.....	85.3	“ “
June.....	85.0	“ “
July.....	85.2	“ “
August.....	85.1	“ “
September.....	82.1	“ “
October.....	81.2	“ “
November.....	82.9	“ “
December.....	87.0	“ “
January.....	84.8	“ “
Yearly average.....	84.2	“ “

Sunshine

Available records for sunshine show the following monthly averages:—

February.....	5.5	hours
March.....	4.3	“
April.....	5.1	“
May.....	4.0	“
June.....	5.2	“
July.....	4.2	“
August.....	6.2	“
September.....	6.8	“
October.....	6.7	“
November.....	6.3	“
December.....	5.5	“
January.....	4.6	“
Average daily sunshine.....	5.3	“

The maximum amount of sunshine for a single day was 11.6 hours on July 30, 1920.

Temperature

Available records of average shade temperature are as follows:—

February	78.0°	Fahrenheit
March	78.1°	"
April	79.0°	"
May	79.2°	"
June	78.4°	"
July	78.4°	"
August	80.0°	"
September	81.1°	"
October	81.5°	"
November	80.3°	"
December	78.6°	"
January	77.8°	"
Average shade temperature	79.2°	"

Placing these months in order, lowest temperatures first, we have the following list:—

January	April
February	May
March	August
June	November
July	September
December	October

The mean, maximum and minimum shade temperatures are as follows:—

		Fahrenheit	
February	82.8°	maximum	73.3° minimum
March	83.2°	"	73.1° "
April	83.8°	"	74.2° "
May	83.2°	"	75.1° "
June	82.8°	"	74.1° "
July	83.3°	"	74.0° "
August	85.0°	"	75.2° "
September	86.5°	"	75.5° "
October	85.2°	"	75.6° "
November	85.9°	"	74.8° "
December	83.5°	"	73.8° "
January	82.5°	"	73.2° "
Yearly average	83.9°	"	74.3° "

Wind

The Station and the research area at Kartabo are located upon an open expanse of four miles of water facing almost due east, so that full advantage is gained from the trade winds, which blow prevailingly from the east, with northeast winds a close second. These breezes from the sea, forty-five miles away, blow almost steadily during the day throughout most of the year, while during January, February and March they continue through much of the night as well.

Occasionally, during the rainy seasons, the wind blows for a short time from the continental side, southeast or even south, and brings with it the heaviest falls of rain.

The wind is remarkably even throughout the year, as shown by the accompanying tables, and varies from "Gentle" to "Fresh" with very few gales and no hurricanes.

Moderately severe thunder storms occur now and then, especially during the changes in the rainy seasons.

The table below gives the average for observation taken upon the force of the wind three times daily:—

February.....	3.5	miles	per	hour
March.....	3.3	"	"	"
April.....	2.7	"	"	"
May.....	2.5	"	"	"
June.....	2.9	"	"	"
July.....	3.1	"	"	"
August.....	3.7	"	"	"
September.....	3.6	"	"	"
October.....	3.8	"	"	"
November.....	3.2	"	"	"
December.....	3.1	"	"	"
January.....	3.6	"	"	"

Summary

Seasons *Two Dry Seasons* occupying seven months of the year, February, March, April, and August, September, October, November; within which two-fifths of the rains fall.
Two Wet Seasons occupying five months of the year, May, June, July, and December, January; within which three-fifths of the rains fall.

In ecological researches at Kartabo, the more natural method is followed of beginning the year with February, the first month of the Short Dry Season.

Rainfall	Average, 100.53 inches (annual). Heaviest—May, followed in order by June, July, December, January. Lowest—March, February.
Humidity	Average, 84.2 per cent. Average 7:00 A.M., 90.9 per cent. 1:00 P.M., 79. “ “ 6:00 P.M., 82.2 “ “ Month of greatest humidity—December. Month of least humidity—April.
Sunshine	Average, 5.3 hours daily. Greatest sunshine—November, April. Least sunshine—January, December, May.
Temperature	Average, shade temperature, 79.2° Fahrenheit. Coolest months—January, February. Warmest months—September, October.
Wind	Prevailing Direction— <i>East to Northeast</i> . Average rate of speed—3.25 miles per hour.

Meteorology of the Coast-lands and the Far Interior Compared with Kartabo

Along the flat, alluvial coastlands, records of weather conditions are taken at many places, the most important meteorological weather station in the Colony being situated at Georgetown. Rainfall and other records have been taken at this Station since 1846, and the figures used are the averages for the available records of this period. The reports show that “the climate at Georgetown is a very equitable one, and one which . . . varies regularly and equitably.”

In the far interior on the savannah country of the plateau regions, records are taken at Eupekari, and at Dada-nawa, both on the Rupunnuni River. Dada-nawa is situated about two hundred and fifty miles southwest by south from Kartabo, at 2° 49' 25.5''

north latitude, and 59° 29' 29.3'' west longitude. Eupekari is nearer Kartabo, about 195 miles in the same direction as Dada-nawa, and is at approximately 3° 40' north latitude and 59° 18' west longitude.

At Dada-nawa the records show that the rainfall is far less regular than at Kartabo, and that it averages lower than the coast-lands, and much lower than the forested region within which Kartabo is situated. The temperature at the savannah stations also has a greater range, the maximum being higher and the minimum lower than at any of the coast stations.

Meteorology of Kartabo

Compared with that of the Coast-lands and the Far Interior

	Coast Lands	Kartabo	Interior Stations
Rainfall.	94.37 inches	100.53 inches	51.88 inches
Humidity	78.1 per cent.	84.2 per cent.	86.5 per cent.
Temperature. . .	80.4° Fahr.	79.2° Fahr.	83.1° Fahr.

III—GEOLOGY

The Colony of British Guiana may be divided into three transverse zones: First, the narrow, flat, alluvial coast-land much of which is actually below high tide level, and which never exceeds an elevation of ten feet, and along the Essequibo River reaches about twenty miles inland. Second, a zone of sedentary sand and clay, in which Kartabo is situated. This lies back of the low coastal region, and extends clear across the Colony. The origin of the sand and kaolin is given later. This zone is one of low elevation, from fifteen to two hundred feet, and is of greatly varying width. The country is undulating and is generally covered with high, tropical rain forest. Third, the mountain zone consisting of undulating plateaus, rising successively from one thousand to twenty-five hundred feet, occasionally cut into deep gorges as the eight hundred and ten foot fall of Kaieteur, and culminating in the flat-topped plateau mountain of Roraima, five thousand feet above the surrounding country and eighty-six hundred feet above the sea.

Rocks, Minerals and Soil

At low tide, a considerable extent of rock appears at Kartabo

Point, extending along the shore from B₆ south to C₅. Again farther south at Boom-boom Point, I₁ and I₂, and J₁ and J there is a great massive outcropping. Of these rocks Sir John Harrison writes that they "consist principally of grey granite but pegmatite or giant-granite is present in abundance. In places good specimens of graphic granite may be obtained. Mica is present in the giant-granite, sometimes in large plates, while here and there red garnets are fairly abundant in the pegmatite veins. A little to the westward the medium-textured light-gray granite is seen with a glistening darker-colored, fine-grained rock apparently intrusive in it. Both are traversed by veins of coarse pegmatite, which in places contain garnets. The fine-grained rock is seen, on microscopic examination, not to be an intrusive igneous rock, but a clastic sedimentary rock caught up in, and intensely metamorphosed by, the granite."

The gray granite almost at the very door of the Research Station represents the basic foundation of earth structure, the very skeleton of the planet, fashioned in planetary flame, upon which the other rocks rest, over which the rivers flow, and standing as a contrast to the evanescent plant and animal life existing upon its great masses.

The granite at Kartabo and near-by points is the largest outcropping in the Colony. Harrison describes it in detail as containing large irregular plates of orthoclase or potash feldspar, in places with albite or milky-white feldspar, numerous small plates of microcline and abundant ones of oligoclase. The feldspars contain some inclusions of small granules of epidote and minute flakes of secondary muscovite, and irregular patches of quartz. The micas are in the form of large plates of muscovite and flakes and wisps of greenish biotite. A few grains of sphene, rarely minute crystals of zircon and some granules of iron-ore are present.

The dominant inorganic character of the research area consists of sands and clays, residual deposits in distinct contrast to the fluvio-marine deposits of the alluvial coastal zone. The rapidity of disintegration of exposed granite in this region is almost unbelievable, breaking down into deposits which are distinguished from finely divided fluvio-marine matter by the relatively great abundance of heavy minerals in the former. Aplite, granite, pegmatite, quartz-porphyrries, the more acidic granitites, and the gneisses and schists derived from them give rise to more or less sandy kaolins and pipeclays, varying in color from white to cream. The beach in

front of the Station consists of white quartz sand overlying firm deposits of creamy-white kaolin. The rocky bank back of this is seen in the process of actual erosion and disintegration. In these deposits from metamorphosed granites muscovite is present in abundance together with small crystalline grains of corundum. In addition to these tourmaline, topaz, beryl, garnet and spinel are found. At Kartabo the inorganic factor in the ecology is a relatively unimportant one, but within short distances metals and minerals are of the utmost importance. Thirty-five miles to the southeast thousands of tons of kaolin have been mined, for the bauxite derivative of the contained alumina; in the Kartabo sand are occasional flakes of gold, while fifty miles to the west paying gold diggings begin, culminating in a spot like Omai, sixty-five miles to the south where from an area of sixty acres over ninety-five thousand ounces of gold have been taken. The diamond fields are no farther away.

At first only a few stray stones were found, but today the diamond-bearing area includes three thousand eight hundred square miles. During the first twelve months of 1923, 1,141,425 diamonds were found, aggregating 214,475 carats. The largest stone weighed $48 \frac{1}{8}$ carats and was found on the right bank of the Kurupung.

Gold mining began in the Cuyuni in 1863, but no great amount was taken out until 1886. The largest nugget found weighed 28 oz. 10 dwts.

Earthquakes

Earthquakes are felt now and then, usually slight and transitory occasionally more severe and with appreciable effects. One of these occurred on May 10th, 1922 at 3:00 A.M., lasting about twenty seconds, travelling from East to West. The laboratory was severely shaken, trees were loosened, and large amounts of earth slipped down along steep banks of the river and inland gullies.

During seven years, six rather severe shocks have been recorded:—

March 26, 1915.....12:25 A.M.

March 29, 1915..... 7:00 P.M.

February 24, 1918..... 7:20 P.M.

May 31, 1921..... 4:30 to 5:00 A.M. Two shocks.

May 10, 1922..... 3:00 A.M.

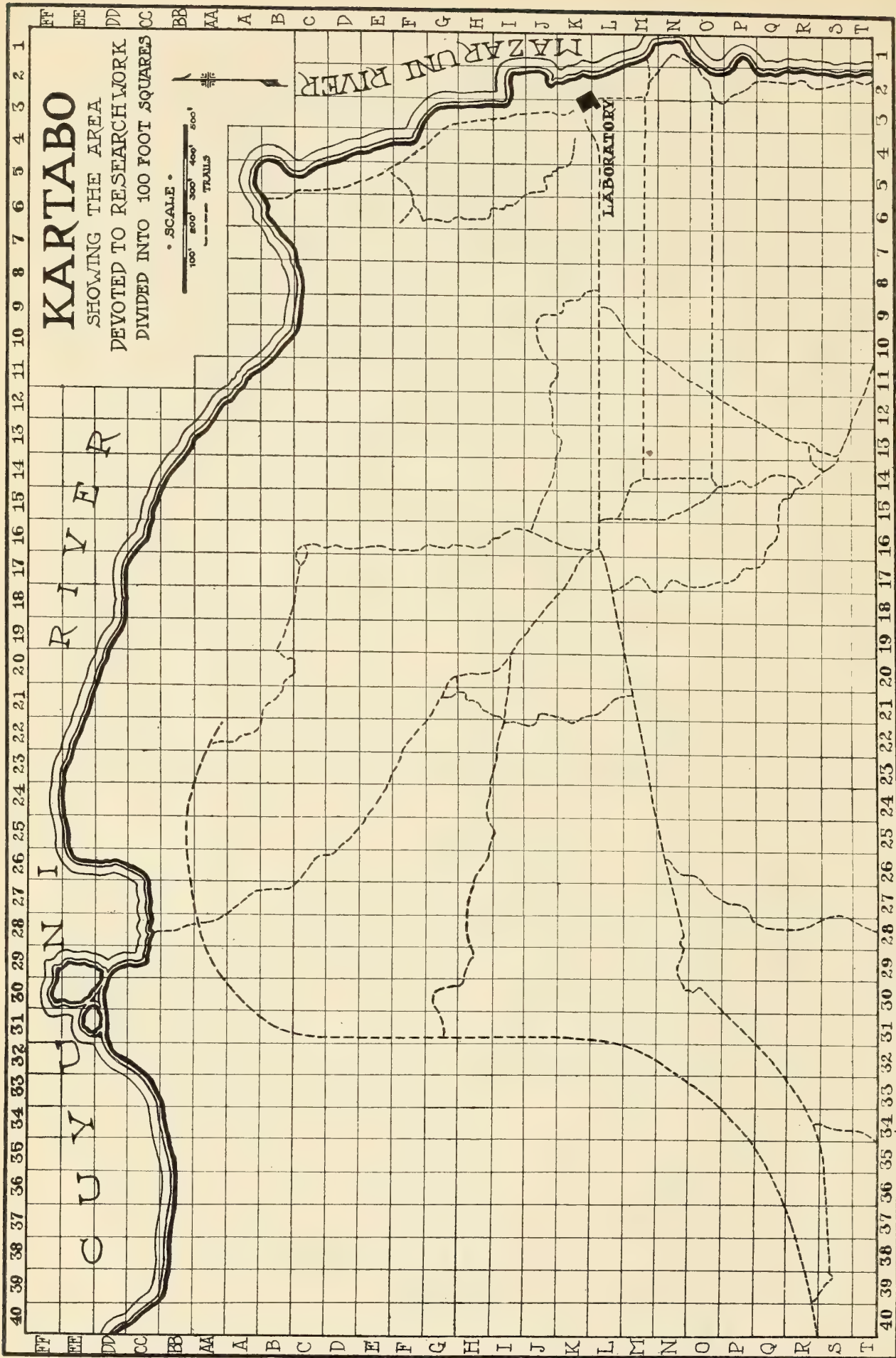


Plate B. Area devoted to research at Kartabo.
Drawing by John 'Tee-Van.

IV—PHYSICAL CHARACTER

Kartabo, British Guiana

Within the approximately quarter of a square mile devoted to research work at the Tropical Research Station, the average height of the land mass may be placed at between thirty and fifty feet above the mean tides.

Along the shore of the Mazaruni River, immediately surrounding the laboratory, the land is flat, averaging about five to fifteen feet above the mean level of the river. Three hundred feet west of the laboratory, and about four hundred feet from the river, the land rises sharply, forming a rounded hill about eighty feet in height, two to three hundred feet through at the base; continuing westward, expanding laterally, until in the western end of the research area it becomes over a third of a mile wide. The northern aspect slopes abruptly downward, while the slope on the southern side is very gradual, occupying about two-thirds of the width of the entire hill. This hill forms the beginning of the divide between the Mazaruni and Cuyuni Rivers, extending southwestward, becoming higher and joining the southernmost extension of the Oko Mountains, thirty miles away.

In the northwestern portion of the research area the hill nearly meets the shore of the Cuyuni River, while to the north and north-east are found swamps and moist lowlands. Southward of the hill rolling lowlands predominate, and swamps are fewer in number and less in extent. The majority of the swamps are formed by the rains, and rarely by springs or underground seepage of water.

Tidal Area and Shore

The shore area of the rivers influenced by tides is extensive and varied, occupying approximately six thousand linear feet, divided into the following:—

Rocks	300 feet
Sandbeaches	650 feet
Shore steep, edge of jungle, tree roots merging with tidal area	1200 feet
Shallow, mud and sand-bottomed flats	3850 feet

On the northern boundary of the research area from BB₃₆ to DD₃₂ on the Cuyuni River, the shore is shallow, with many rocks

scattered about on the mud and sand of the bottom. Jungle trees come to the edge of the water, their roots often forming an intimate portion of the tidal area,—the water lapping over many feet of their buttressed supports.

From DD₃₂ eastward to about EE₂₂, the area including the two Cuyuni Islands and Emerson Bay, the tidal area is small and the shore drops away rapidly. Trees come to the edge of the water, but mangroves and a consequent shallow shore are not present, due mainly to many swirling whirlpools within the bay, and to the currents of the Cuyuni on the outer portions, which at this point are very swift. There is much rock to be found on the shores of the two islands, especially about the easternmost larger one. This rock is continuous with a line of rocks which project northward for two to three hundred feet, partially exposed at low water. The remainder of the Cuyuni shore from EE₂₂ to the easternmost portion of B₇ is shallow and shelves slowly, most of the bank being covered with mangroves.

The point of land which marks the dividing line between the Cuyuni and Mazaruni Rivers has an extremely small tidal area, and is formed of rocks descending sharply into deep water.

Passing around the rocks at the point of land to the Mazaruni side of the research area, the tidal space is first formed of coarse whitish-yellow sand (B₅ to E₄), shelving rapidly on its northern end, and merging to the south with shallow mud and sand bottom banks covered with mangroves; this shore descends very slowly into the deeper portions of the Mazaruni (E₄ to H₃). A large outcropping of gray granite forms the next portion of the shore, bare and forbidding in appearance (I₂, J₂), with many sharp, jagged pieces on the mud and sand bottom, which is continuous with the remainder of the shore.

To the south of these rocks (J₂ to M₁) is the beautiful, three hundred foot long sand beach, which extends in front of the laboratory. This beach is mainly formed by the breaking down of the fifteen foot cliff-like bank of clay and sand in front of the station. It is continuous with the great bank of coarse, yellowish-white sand which extends down river for over three-quarters of a mile from the laboratory. This bank has been formed by the constant swirls and eddies caused by the meeting of the two great rivers. During very low tides, it is possible to walk down stream for over half a mile, without finding more than two feet and in many places only six inches of water.

Below the sand bank another group of gray granite rocks are found (N_1), followed by a steep, yellow clay bank (southernmost part of N_1 and northernmost part of O_1), fifteen feet high extending for about fifty feet. This borders on shallow sand and mud flats which abutt on jungle trees and tree roots, and extends to the southeastern end of the area devoted to research work.

Water

The area at Kartabo devoted to research is bounded on the north by the Cuyuni River, which at this point is not quite half a mile wide (2500 feet), and on the east by the Mazaruni River, whose nearest point on the opposite shore is nearly a mile and a quarter away (6350 feet).

The tides on these huge rivers are swift, the downward current running from one to three miles an hour. The average rise and fall amounts to from six to six and a half feet. During seasons of high water at full moon tides the waters are often six to eight feet higher than the usual high tides. Five miles above Kartabo the tides in both rivers end, as at that point the first rapids are found.

At Georgetown and at the mouth of the Essequibo, forty-five miles downstream from Kartabo, the tides average about two and a half hours earlier than they do at the station.

The time occupied in rising and falling is influenced greatly by the amount of water flowing down from the upper reaches of the rivers. The difference sometimes varies to the extent of a falling tide of nine hours and a rising tide of two and one half hours.

The color of the water is a pale brown, mainly caused by the stains derived from the leaves of the wallaba tree (*Eperua falcata* Aubl.). At 8:30 A.M. with the sky half covered with clouds, the color in the shade approaches nearest to olive-brown (Ridgway). But the influences of shade and depth are such that the water appears to have a greenish tinge instead of reddish. Lowering a white disk six inches in diameter into the water, the color is quite yellowish at the surface, becoming browner farther down, and near the point at which it disappears acquires a distinct orange tone.

Experiments at 8:30 A.M. give the following color values, as compared with Ridgway's "Color Standards and Nomenclature," observed over a six inch white disk at different levels:—

Surface. White

1 inch.....	Cartridge Buff
2 inches.....	Colonial Buff
3 inches.....	Deep Colonial Buff
4 inches.....	Warm Buff
5 inches.....	Antimony Yellow
6 inches.....	Dull Capucine Orange
12 inches.....	Zinc Orange
15 inches.....	Vinaceous Fawn
18 inches.....	Russet Vinaceous

From eighteen inches downward the colors become darker and darker, and at twenty-five inches the disk disappears from view. This depth of twenty-five inches at which the disk disappears is to a great extent independent of the position and intensity of light from the sun, and is brought about almost entirely by the amount of stains and coloring matter held in suspension by the water. Experiments with the sun directly overhead, or at an angle of 30 to 35 degrees give the same result,—a blocking out of the disk at twenty-five inches.

Occasionally during heavy rains about the upper portions of the rivers, quantities of brownish yellow coloring matter, in appearance much like the yellow-brown Amazon mud carried in suspension by the sea along the coast of Guiana, is brought down. During the second and third weeks of May, 1922, the waters of the Cuyuni were deep brownish-yellow, quite opaque, so much so that one's hand disappeared from view six inches below the surface. The difference between the clear waters of the Mazaruni and the colored water of the Cuyuni was especially noticeable at Kartabo.

On the sand beach in front of Kartabo, the temperature of the water below the surface and near the bottom averages 79–80 degrees Fahrenheit.

Within the area devoted to research there are a few small streams, which disappear to a great extent during the dry season. At the northwestern portion of the research area is a single larger creek about ten feet across.

V—THE FLORA OF KARTABO

The flora of Kartabo has been studied by no competent general botanist, and in this résumé I have attempted nothing but an indication of the more conspicuous and abundant growths, particularly

those which possess an important relationship with members of the vertebrate fauna, either in the way of food, homes or media of support and progress.

Fluviatile

Blue-green, red and brown algae and diatoms are abundant but no collections have been made of them. Very remarkable purple algae have been found in the stomachs of puffers but not observed elsewhere. Both the two- and three-toed sloths have the well-known peculiar green algae growing on the dorsal hairs.

Littoral

The littoral flora is sharply delimited to between tide marks. Where the current is swift near shore, these forms are almost hidden by overhanging vines and lianas, dependent from the high jungle trees which crowd down to the very water. Along sandy and sloping muddy shores they are spread out, but even in such places do not extend more than a few yards from the high tide mark. Specific associations are well marked in the littoral flora, solid cultures of mangroves, sedge, mucka-mucka and others.

The mangroves, *Rhizophora mangle* Linné, find root-hold in certain definite areas of the gently sloping mud-flats, feeling their way far out, with long steps, foliage held high out of reach of the water. They are in no sense shore builders, they do not attempt to stay the tide, but allow it freedom to wash back and forth.

Back of them, on firm mud and sand, the tall graceful sedges live out their half aquatic, half aerial lives. The two dominant species are the White-plumed Sedge, *Eleocharis geniculata* R. Br., and the Starry Sedge, *Cyperus* sp. The former are gigantic in favorable spots, with their triangular, forest-green stems reaching up twelve feet, while the latter present lowlier clumps topped with the fluffy white catkins. This one grows in denser clumps and is a better land holder, but the roots do most of the work. The stems survive the wash of waves by their pliability, giving instead of breaking.

In spots where the current is not too swift or waves too violent, appear rank upon rank of that aroid lily with the incongruous name of Mucka-Mucka, *Montrichardia arborescens* (Linné) Schott. The tall stout stem sends off great arrow-heads of leaves, and occasionally



Fig. 3. Mangrove beach at Kartabo.
Photograph by John Tee-Van.

a large white calla-like lily and later the pineapple fruit. Here and there are small patches of Horse Tails, *Equisetum*, hinting of epochs long since past. In 1919, these were confined to an area of not more than two square yards. Two years later this particular section had been washed away and I have found no further trace of these plants.

Clustering around the sedge clumps, like dug-in outposts, are the low, white-flowered *Diodia*, creeping along the sand and helping the coarse grasses to cling to the shifting grains. The most conspicuous flower stalks of the fore-shore are the tall Shore Gentians, *Coutoubea spicata* Aubl., which hold up their racemes of pinkish-white flowers well below high tide level. Their roots go deep and after a severe storm they seem to suffer less than some of the stronger growths.

One of the most valuable shore-binders is the rush-like herb, *Xyris tenella* Kunth. Hundreds of these little grassy-leaved plants take root beneath the mangroves and their roots mat together while their tall, clubbed-top stems rise bravely and expand tiny yellow blooms. With them occur the straggly, jointed stems with the inconspicuous pea-like flowers of *Vandellia difusa* Linné.

Very numerous, but so tiny and fragile that only close examination reveals their existence, are Utricularias bearing minute yellow blossoms.

On beaches of pure sand, fronting disintegrating, soil-covered banks, the plant association is of another character, all uniting to hold fast to as much as possible of the granitic talus which now and then slides down in sandy avalanches. Such is the beach directly in front of the laboratory.

Every inch of the precipitous bank which offers foothold is covered with representatives of the clearing flora,—the pink and white Mazaruni primroses, *Sipanea pratensis* Aubl., being the only bright color note.

At the foot of the bank the force of the tides is felt and the plants are no longer the gentle growths of a summer meadow, but must be sufficiently virile to hold their position against water and wind. As opposed to the mangrove zone, the dominant plants here are grasses. Close to the bank clumps of great, coarse beach grass, *Panicum* sp., sprout, with stems bent, but measuring ten feet in length. Farther down shore are creeping grasses, *Courmelina longicaulis* Jacq., whose stems seek safety by allowing themselves to become half buried in the sand, with leaf tips coming up for breath.

These are perhaps the best sand-binders, and given half a chance will form a mat of their interlacing stems, which holds fast to the grains. Smaller clumps mimic the larger, and *Sporobolus* succeeds by developing strong roots but soft pliable stems, which, even in the air, lie prostrate, like green tresses combed back by the touch of the last wave, until the next incoming tide washes them to and fro like the softest algae. In surprisingly exposed places the curious little clover-like, purple-flowered *Desmodium* stands bravely in low, compact bunches, while *Kyllinga* with its small white flowers creeps feebly a few inches from its roots. These, with a few isolated plants of sedge, form the outliers of the plant world, in the ever shifting zone between solid land and the impassable barrier of low tide.

The mangroves cheat the jungle and find their light and air far beyond the competition of the great moras and purpleheart, where, although thriving a few yards away, these mighty trees cannot follow. Like most get-rich-quick schemes, however, the mangroves yield to the law of compensation, and every branch, twig and root has its parasites and epiphytes. Bromeliads, in serried rows and clusters, are so abundant that they sometimes break down their very support. The roots above low water are coated with moss and lichens, while the branches are often put under terrific strain by burdens of heavy vines, such as *Souroubea guianensis* Aubl., and its interesting relations, several species of *Marcgravia*. Even the topmost twigs are not free from invasion. While the mangroves' own flowers are small and inconspicuous, the epiphytic orchids are numerous and beautiful, and when they are in full flower their odor and color make it a delight to canoe through the arching roots. The most abundant forms are *Epidendrum fragrans* Sw., *Epidendrum nocturnum* Jacq., and *Diacrium bicornutum* (Hooker) Benth.

While the actual flora of the tidal area is limited and fixed, yet this zone offers one of the most fertile fields for another phase of botany,—the flotsam and jetsam of the river current. Every receding tide leaves a host of stranded nuts and seeds. As I once wrote of this same current farther down stream, "There were spheres and kidney-shapes, half-circles and crescents, heads of little old men and pods like scimitars and others like boomerangs. Some were dull, others polished and varnished. They were red and green, brown and pink and mauve and a few gorgeous ones shaded from salmon into the most brilliant orange and yellow. Most

were as lifeless in appearance as empty shells but there were many with the tiny root and natal leaves sprouting hopefully through a chink."² And so along the line of the highest tides scores of small plants are often found sprouting, which have drifted down many miles from hinterland jungles.

Jungle

Unless artificially altered by man, the littoral flora merges directly and abruptly with that of the jungle. The outermost trees may be a mangrove with strong buttressed trunk, and little to indicate its spidery, amphibious character farther riverward. Close alongside is a tall jungle tree, perhaps a mora, which reaches up a hundred and fifty feet, or a purple-heart almost as tall.

At Kartabo some of the river jungle is swampy, with palms as a dominant association, mingled with hard and soft wood trees. Passing to dry or higher ground, we find the typical rain forest of Eastern South America. It is impossible to describe in accurate detail, for every square yard, every dense thicket or open glade has a character of its own. In the most luxuriant primeval jungle, the great trees rise at considerable distances from each other, with trunks straight as plummets, and often quite bare of branches for one hundred feet. They support such a dense canopy of their own and of parasitic foliage that there is always a dimness as of twilight beneath. The undergrowth is scanty and low, and the midjungle is broken only by occasional lianas or aerial rootlets, all of which are as straight as the tree-trunks.

Where plantations of the Dutch once existed in the far distant past, or more recent clearings made by the Indians for cassava, the new growth never quite regains its maximum development. In these changed conditions, while there are very many large, very tall trees, yet there is not the unbroken aspect of the roof of the jungle, and the undergrowth instantly reflects this in its more lush character, both in abundance of aspiring saplings and in lesser ferns and shrubs. Jungle of these and of intermediate types is found in the research area.

In swampy areas *Ichnosiphon* grows luxuriantly, tall, smooth, reed-like green stems, with a burst of leaves at the summit. Ant-birds sometimes build in the heart of the foliage head, and the split

² Jungle Peace, p. 75



Fig. 4. Palm swamp near the Research Station.
Photograph by John Tee-Van.

stems are used by the Indians in basket making. Comacuballi lianas climb trees and palms and thrust out masses of red berries beloved of birds. In these places wild ginger, escaped from long forgotten plantations, sends its six to twelve foot leaves up from compact clumps, and *Heliconias* run riot.

Even in low jungle one can always see through the undergrowth for ten to thirty yards, and while interlacing vines sometimes make going difficult, usually it is only fallen trees and branches which hinder one. Thorns are rare, but when they do occur, as on the climbing palms, it is useless to force one's way. They must be patiently pushed aside or cut away. The jungle floor is never bare. One may tramp for hours and never know whether sand or black mold is the substratum underfoot. There is always a thick mat of fallen leaves and twigs, sometimes an inch or two, sometimes a foot deep. Digging down we find these gradually altering from the leaf which has just eddied down, through blackened, half decayed leaves to homogeneous, earthen mold, ready to be drawn up again into living sap. In the dry season the leaves crackle at every step, in the wet they are silent to the foot, and soaked, but always they are present. No thick growth of moss lies underfoot but every inch of twig and branch and trunk is painted and hung with fungi, lichens and moss.

In deep jungle, flowers, up to man height, are not uncommon, but inconspicuous, but fallen petals and blooms are abundant, often having dropped a hundred feet from some obscure vine, not distinguishable from the foliage at that height. Or zones of intense sweetness will indicate flowers which are invisible. If looked for, dozens of inconspicuous greenish blooms will be found low down or springing from the mold, but at the least hint of glade or open trail, color becomes evident, and the sombre jungle loses its meaning.

Color in masses is to be found in the tree-tops when whole trees burst into a solid head of lavender or pink within twenty-four hours, or along the river banks, where hanging vines transform overnight into floral avalanches. Another source of color peculiar to the tropics is the brilliance of new leaves. A Kartabo spring reminds one of the northern woods at the height of autumnal change. This leaf coloring holds even in the dark jungle shade, and here too the pigmented place of flowers is taken by the leaves of caladiums, of *Tontanea* and of *Coccocypselum*, on whose chlorophyll palettes are spread splashes and lines of white, cream, pink and scarlet.

Lichens, fungi and mosses are everywhere. Even in the dry season, they flourish in damp places, while during the rains they rival the flowers of the glades in color, and are of every conceivable form and shape, mimicking on a small scale all the greater growths of shrubs, trees, vines, besides adding such similes as umbrellas, lace-work, and pagodas. As for molds, smuts and rusts on the leaves of jungle growths, a mycologist who spent four days at the Research Station collected three hundred forms in a few trips along the trails.

The importance of this density of vegetable growth covering every inch of dry land, cannot be appraised too highly, no matter what form of organic life we choose for intensive study. It actually brings into existence a new land of organic life,—secondary, pseudo meadows and aerial fields, a hundred feet or more above the solid ground, transferring to these hanging gardens the color and variety of foliage, flower and fruit, as well as specialized animal life of every group, which for our lowly structure and limited senses exists elsewhere only in open clearings.

Jungle Trees from Sixty to One Hundred and Fifty Feet,
Rarely Two Hundred Feet in Height, Found in
the Research Area

Dimorphandra excelsa (Schomb.) Baill.

Mora: One of the tallest of jungle trees, often with enormous buttresses; common close to tide or in swampy places.

Nectandra rodiei Schomb.

Greenheart: Another giant of the tropical rain forest, the most sought for commercial wood; much heavier than water.

Carapa guianensis Aubl.

Crabwood, Guiana Mahogany: Very tall trees, second in value commercially only to greenheart. It is the cheapest Colony timber. Crab-oil is made from the kernel of the fruit.

Pentaclethra macroloba (Willd.) Kuntze.

Trysil: Medium to large timber trees, usually near water; very finely divided foliage, long tasseled flower panicles attracting hosts of insects. In full flower throughout May.

Aspidospermum excelsum Benth.

Paddlewood, Yaruru: Several large trees in the area; stumps of

others show where the Indians have obtained paddles in past years.

Rhizophora mangle Linné.

Mangrove: Forms a pure culture littoral fringe in many places.

Spachea elegans A. Juss.

Pigeon-berry: A tree of medium height thriving both in jungle and clearing, covered in April with a dense mass of paniced blossoms, attracting hosts of insects and birds. A decoction of the bark is an astringent, used by the Indians for dressing cuts.

Inga sp.

Waikey: One of the few soft-wood trees; medium to large, smooth, whitish bark, moderate pointed leaves.

Hevea sp.

Hatteeballi: A tall tree of deep jungle.

Sapium jenmani Hemsl.

Wild Rubber: Grows to very large size; does not die when exposed to direct sunlight by the cutting of surrounding jungle; smooth-barked; the tallest trees develop thick buttresses.

Vochysia tetraphylla DC.

Etaballi: Tall jungle tree, with large bole, slightly roughened or scaly bark, rich, dark green foliage, golden brown wood with silver grain, bursts suddenly into bloom about April 1st, the flowering lasting throughout the month. A second season of less luxuriant blossoming begins August 15th.

Cassia multijuga Rich.

Guana: Tall white-barked tree, finely divided foliage, conspicuous yellow flowers, abundant along river banks and near clearings; very abundant. Height of flowering September 1st to 15th. Exceedingly attractive to insects.

Anacardium rhinocarpus DC.

Wild Cashew, Hoomalgee, Hubudi: Tall tree of deep jungle.

Spondias lutea Linné.

Wild Plum, Hog Plum, Hoobooballi: Tall jungle tree, thriving also in clearings. The yellow, oblong, delicious smelling fruit is eaten by birds, animals, and Indians; bark rough with longitudinal lines, pinnated leaves. Most individuals begin to drop fruit in late February, and continue steadily for four months, the last falling in July.

Other trees, perhaps close by, but fewer in number, begin their season of ripened fruit August 15th and end in November.

Copaifera pubiflora Benth.

Purpleheart: Uncommon, very large jungle tree; one of the tallest in the research area recently fell into the waters of the Mazaruni. It showed three hundred and eighty annular rings. The heart is deep purple or magenta, and is extremely hard; logs free from sapwood are sometimes a yard square.

Piratinera guianensis Aubl.

Letterwood, Snakewood: Chocolate wood with patches of brown and black, like the skin of some snakes; used for canes and small ornamental objects, and by the Indians for bows, although very brittle. The trees are small, full-grown ones being only sixty feet high; once abundant, as indicated by old Dutch reports of cargoes exchanged with the Indians for this wood; now a few small saplings only are left in this locality.

Hymenaea combaril Linné.

Locust, Siniri: Tall, with smooth bark, beautifully banded with red, gray and yellowish, like layers of clay; very finely divided foliage. The wood is orange-red. The Indians make wood-skin canoes from the bark.

Hieronyma laxiflora Muell. Arg.

Suradanni: Deep red wood, cross-grained, good for gun-stocks and canoes. One of the largest trees of the research area jungle is of this species.

Simarupa amara or *officinalis*.

Simarupa, Matchwood Tree: Wood milk-white, soft; one of the tallest trees, projecting high above the surrounding jungle. The only jungle tree we have been able to scale, reaching a height of eighty feet by means of two alternating rows of large spikes driven deep in. The second year a newly established nest of stinging bees made it impossible to climb. Deeply lined bark, well covered with moss and lichens, very finely pinnated foliage; used for boards and match sticks.

Unidentified.

Dalina: A tall forest tree with exceedingly hard wood. Trunk deeply grooved, often looking like a mass of lianas; leaves large and oval.

Cecropia palmata.

Cecropia, Congo Pump, Pumpwood, Wanasuru: Very tall and rapidly growing tree in jungle, also springing up in abandoned cassava fields. Wood light, used for floats. In tall jungle individuals, the base is supported by mangrove-like flying buttresses. Enormous leaves in a complex cyme, rattling together loudly in the slightest breeze. The sole food of three-toed sloths.

Unidentified.

Kurahara: Although producing logs fifty feet long by twenty inches square, and excellent for making furniture, canoes and spars, yet this tall tree is unidentified. The wood is reddish brown and takes a fine polish. In K 14 is a young tree with straight, bare stem and a rounded canopy of leaves, umbrella-like. The leaves form a large palmated cluster on the end of a very long, straight, horizontal stalk, arising directly from the trunk.

Unidentified.

Meerah-wood, Antwood: A very large tree, getting its name from harboring a species of stinging ant.

Unidentified.

Hooroo-wassa: A very large jungle tree, small, short-oval, pinnated leaves, and with small curved bean holding about ten seeds; bark light colored, flaking off in scales, as soft as pine. An enormous one in N 11, supporting masses of very large epiphytes.

Myristica surinamensis Roland.

Dalli: Very rapid growing, soft wood; rare, only one or two trees near laboratory. Trunk tall and straight, whitish, coarse pinnated foliage.

Unidentified.

Wareemeah: Common tall jungle tree. On one, which was cut close to the laboratory, ninety-three species of ants were found by Professor William M. Wheeler. Sprouts come up very quickly from the stump.

Nectandra sp.

Silverballi: Bark silvery white, branches wide spreading in young tree.

Unidentified.

Potchuwee: Tall tree, uncommon.

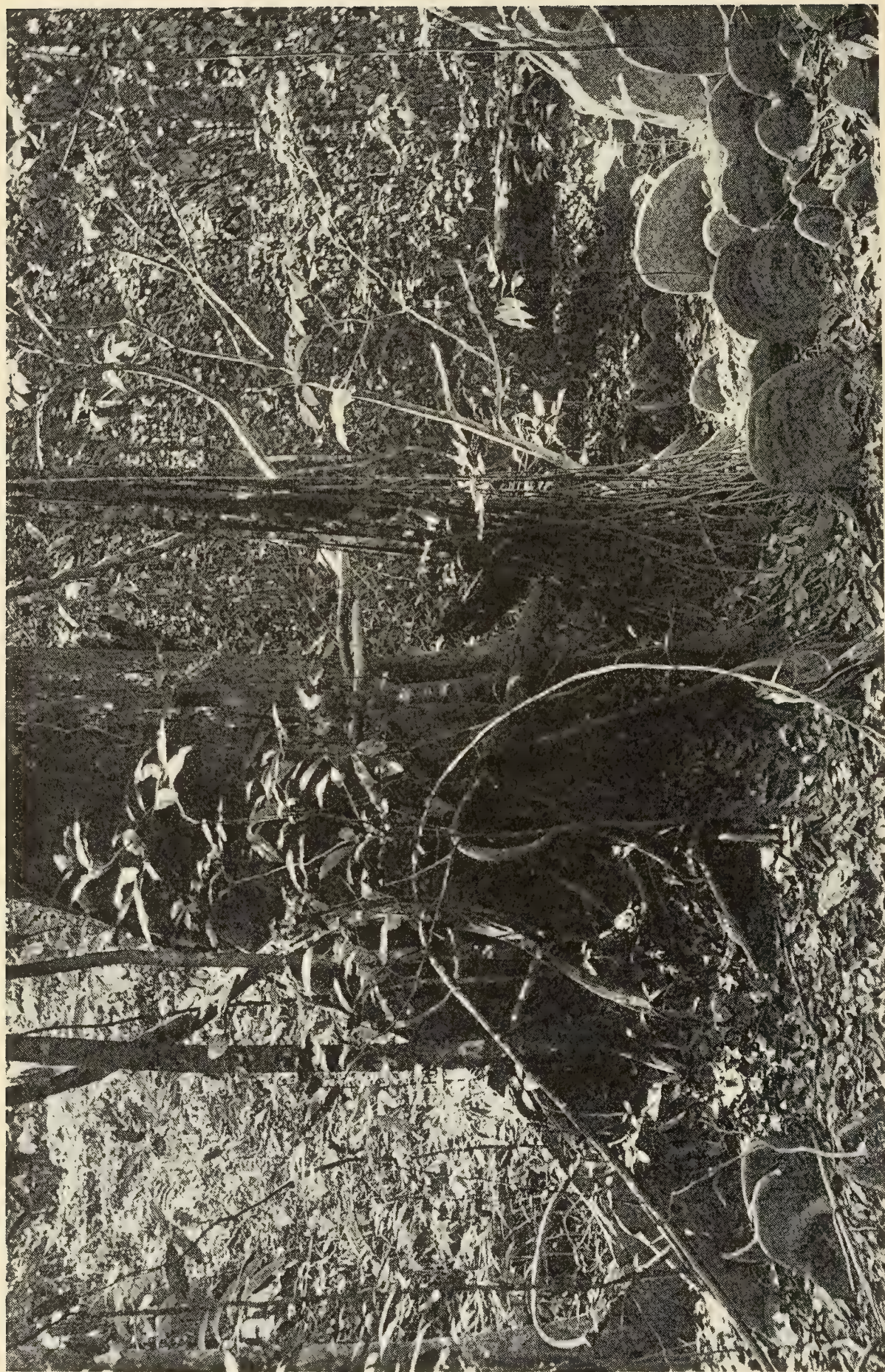


Fig. 5. A Mora swamp, where great exposed roots writhe and twist in fantastic shapes.
Photograph by Thomas Smolucha.

Tapirira guianensis Aubl.

Duka: Occasionally found in the jungle, eighteen inches through; the bark is reddish, not light, and the trunk marred with old branch stubs. Very rapid grower in new clearings. Has edible, purple, grape-like fruit.

Unidentified.

Arrancanduck: Moderately tall tree, large coarse leaves.

Psidium guava.

Cockreeou, Wild Guava: Medium tree, olive gray bark, smooth as if oiled. Many stems shoot up from old stumps; large broad leaves. Introduced from high lands.

Humirium floribundam Mart.

Tauroneero: Large tree, often with a few dead upper branches on which birds love to perch. Abundant. Fruit is edible, wood dark reddish, extremely hard.

Tenipa americana Linné.

Makreekoonee: Fairly tall jungle tree, variegated, slightly roughened bark, medium sized leaves. Bark makes a black dye.

Jungle Palms

Astrocaryum tucuma Mart.

Cuyuru Palm, Acqueero: Thorny-stemmed, a tall sentinel in front of laboratory: fruit eaten by Indian children and by animals.

Maximilliana regia Mart.

Kokorite Palm: Grows very tall; small, recently sprouted ones are common.

Cocos nucifera L.

Cocoanut Palm: A single one, full grown, in D 6.

Mauritia flexuosa L. f.

Eta Palm: Enormous stemmed and leaved, with equally large curtains of blossom and fruit. A very large one at edge of tide in G 3. The young, unopened leaves furnish the well-known tibireri twine, of which "grass" hammocks are made; the dry, pithy stems of the petioles make excellent razor strops.

Euterpe edulis Mart.

Manicole Palm: Characterized by huge palm-leaf fan fronds.

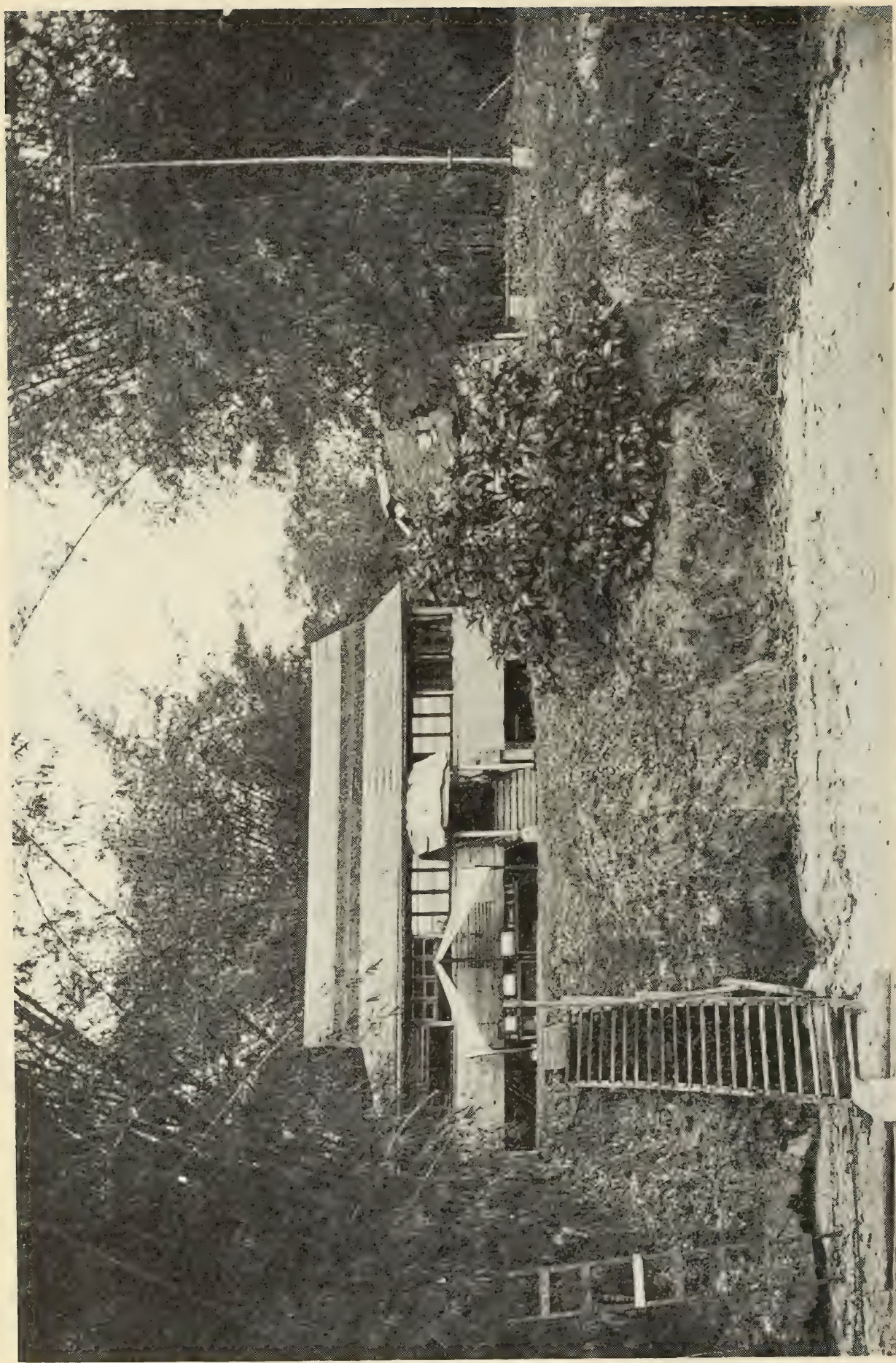


Fig. 6. The jungle laboratory at Kartabo, beneath giant bamboos planted 300 years ago by the Dutch.
Photograph by Paul G. Howes.

Clearing

Immediately about Kartabo laboratory are twenty-five clumps of bāmboo, covering a compound of three acres. These are a very tall Javan species, imported and planted by the Dutch two hundred and fifty or three hundred years ago. They are ideal for bungalow trees, as they provide abundant shade, yet let the air pass freely; they are almost immune from insect attack, and their dense carpet of leaves forms a clean dry footing and prevents the growth of weeds. They respond to the least care, and when a clump is cleared out, the young shoots appear and grow with astonishing rapidity. A new sprout two feet high may in a very short time tower far above one's head. We made two estimates of growth, during the early part of the rainy season, and found that vigorous young shoots grew from eight to twelve inches a day. One of these increased in height from three and a half to sixteen feet in sixteen days. Parasites are unable to gain a foothold on the clean, hard, siliceous stems, and even the leaf-cutting ants have no use for the leaves.

West of the laboratory is a clearing of seven acres which four years ago was in coarse grass. Even after this time it could still be called a clearing, but another full year reduced it to a glade, with tall saplings sprouting in all directions, and the jungle creeping in from all sides. This change is a most interesting one, and the alteration from jungle affords opportunity for hosts of strange organisms, floral and faunal. Throughout the area covered by most of the research work at Kartabo Point, two thousand by four thousand feet, as well as further inland, numerous trails have been cut, which afford easy access to the lateral areas of jungle. To the south of the laboratory a field is cleared and under cassava, bordered by tall jungle trees, and this again exhibits entirely different associations rich in new conditions of floral relationship.

In the clearing, every patch of open ground is carpeted with a dense growth of the cheerful little pink Mazaruni primroses, *Sipanea pratensis* Aubl.,—by far the dominant color note of the open and with many tiny weevils and other insect hosts. With them are numerous other small flowering plants, such as *Spermacoce verticillata* Linné and *caerulescens* Aubl., and such curious little growths as the Christmas-tree plant, *Dupatya*. The waist-deep, meadow-like parts show dense growths of Vervain, *Stachytarpheta cayennensis* Vahl, and Velvet Leaf, *Sida cordifolia* Linné, together with clumps

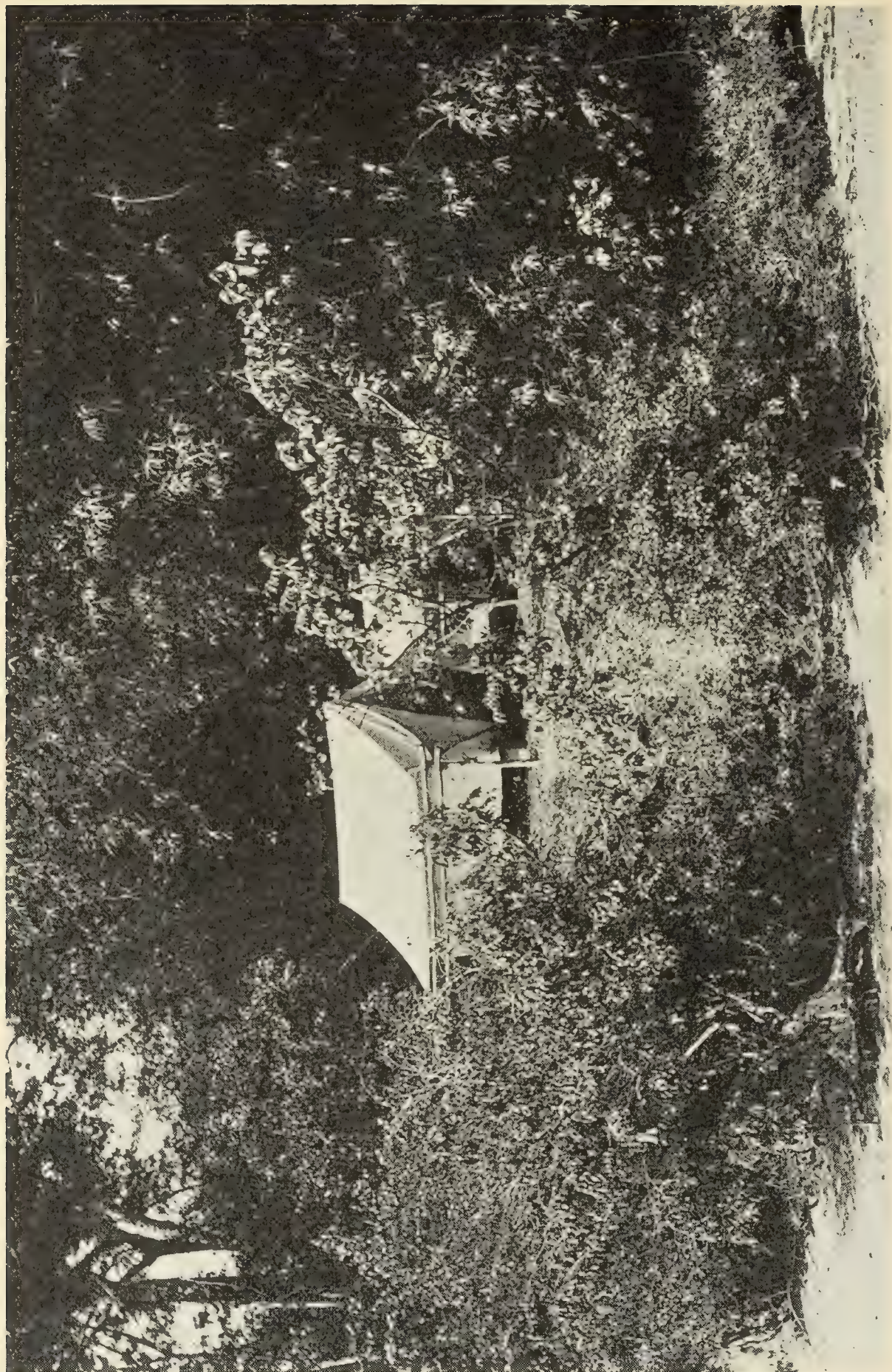


Fig. 7. The row of tents at the edge of the jungle that serve as sleeping quarters for the Staff.
Photograph by Paul G. Howes.

of plume-grass and scores of unnamed growths. Scattered here and there are taller patches of Orinoco boneset, *Mikania orinocensis* H.B.K., some of which burst suddenly into flower at the end of December, while others blossom from March to May. It harbors many interesting Hemiptera,—coccids and membracids. Sprouting plants of Cashew, *Anacardium occidentale*, are common. The fleshy, pear-shaped receptacle of the fruit is an edible astringent, greatly beloved of tanagers and other birds, and the kernel of the kidney-shaped fruit at the end of the receptacle, when roasted, is an article of commerce. The intermediate layer of fruit contains as acrid caustic oil.

In unexpected places great clumps of strange lilies, *Cruium*, spring up, their beautiful white petals filling the whole compound with their fragrance, and isolated plants of scarlet tiger lilies tear colorful gaps in the mass of clearing green. The pinwheel flower, *Tabernaemontana undulata* Vahl., shows one of the most amazing floral-fruit transformations, its gaping scarlet and black fruit developing from the tiniest whorls of petals. There is also the Tree of Life, *Bryophyllum pinnatum* (Lam.) Kury., as much at home as I have seen it in Ceylon and a score of other places. Sensitive plants, *Mimosa polydactyla* H. & B., wilt at a touch and scattered about are stray bushes of Indigo, *Indigofera* sp.,—heirlooms of thrifty Dutch settlers, which have handed down their seeds for perhaps three hundred years. Vines wind in and out, simulating the lianas of the nearby jungle, unnoticed until revealed by a sudden burst of blossoms, as the allamandas and convolvulus.

A still larger growth may be defined as saplings, of which the Duka, *Tapirira guianensis* Aubl., is the most rapid grower. At present there are scattered through the western part of the clearing, dozens of their light-colored, lichen-marbled trunks, with oval, pinnated leaves. With these, young jungle trees, such as Wareemeah, are sprouting from stumps of the old forest. There are also a few lime trees, *Citrus medica acida*, planted many years ago, and smothered in low growths, but still bearing abundantly. Guavas, *Psidium*, also grow here and there, and attract birds and wasps and even small mammals which feast on their fruit.

Here and in many other places, both clearing and jungle, *Me-lastomas* grow rank, some as trees, others as shrubs, bushes, or even crawling, vine-like, over open sandy places. One form, called Mesopra by the Bovianders, *Bellucia grossularioides* Triana, is common

about the bungalow, with great, coarse rough leaves, woody, scaly stems and rounded white blossoms, all a haven for a whole fauna of insect life, while the whitish berries are delicious eating.

The Clearing Trail, which is merely the beginning of the seventy-two mile Puruni Trail, where it leads westward through the clearing is perhaps the most interesting place near the laboratory. It lies along the seam, the very point of meeting of jungle and clearing, and a single yard to left or right often marks an entirely distinct flora and fauna.

The jungle edge hides its bareness with a dense growth of shrubs and half trees, often flowering profusely and attracting hosts of insects and birds. Among these is torchwood, or Haiawa, *Icica heptaphyllum* Aubl., with its dense foliage, whose wood, when pounded and teased out, is used by the Indians for candles, Blood-leaf, *Vismia ferruginea* H.B.K., and *guianensis* Pers., with great leathery leaves, beloved by a multitude of insects, Trysil Trees, with the finest of pinnated foliage, Arrancanduck, and Cassia, whose great golden panicles are Mecca to all lovers of nectar, whether scaly or feathered, with six legs or two. Here too we find tree Cashews, Clusia, Wild Cocoa and Messopra, with small flowers, and Maibike with its stems lined with lavender bloom. Here grow the exquisite Shooting Star blossoms, *Posequeria latifolia* R. & S., whose ultimate seeds look like rounded pebbles of translucent quartz.

Along shore, the edge of the jungle is varied by many smaller trees and vines, some of which are characterized by great solid masses of bloom at certain seasons.

Here grows the wild cocoa, *Pachira aquatica* Aubl., flowering twice a year, each blossom a foot across, a plume-like mass of lilac-colored stamens, followed later by the great leather colored pods, the resemblance of which to cocoa pods gives the common name. The close-packed seeds are delicious, either raw or roasted. Cassia is common here, and *Posequeria*, but vines have the best chance and a single plant may sometimes ramify for several hundred feet along the wall of jungle foliage, climbing to the very top. Especially noticeable are Allamandas, Bignonias, Petrea, and *Souroubea guianensis* Aubl., the last with its glossy leaves and panicles of stiff, scarlet flowers, whose fragrance is delicate and very penetrating. When a tree is entirely covered with this vine in full flower, it is a source of constant attraction to honey-creepers, hummingbirds and hosts of bees. Its near relative, *Marcgravia*, vies with it in abundance along

the shore and sometimes presents a solid front, quite obscuring the foliage of its supporting host behind. Its umbels of curious nectaries surmounted by the drooping circle of flowers are still a mystery as to their exact method of fertilization, whether by hawkmoth, hummingbird, or otherwise.

Another shore plant, which in certain positions becomes almost a vine, is the caterpillar flower, *Combretum laxum* Loebl., with its brilliant yellow and scarlet blossoms, which day by day unfold more of their furry lengths.

The Maibike, as the Akawais call it, or Aliku, Benda, or Waikée, as the Bovianders name it, *Pithecolobium latifolium* Benth., forms bushes or moderate sized trees growing along shore, flowering in mid-July—a mass of rose colored bloom, solidly lining the branches. Bees, butterflies and many other insects come to it in swarms.

Spider lilies, *Hymenocallis*, hold up their drooping, streaming petals from among the sedges and reeds, while in swampy areas grow great clumps of ginger lilies, *Hedychium coronarium* König; in dry clearing edges appear, in the early rains, single plants of scarlet tiger lilies, *Hippeastrum*.

Although the jungle growth is so luxuriant, yet the soil is very thin, a mere skim of black mold from six inches to two feet lying on the sand or clay. An Indian's cassava field planted in fresh-cleared jungle soil will so deplete the ground that a second crop is never attempted, but the Indian allows the jungle to cover the clearing, while he cuts a new one.

In this immediate vicinity, on the opposite side of the river at Kalacoon, three exhaustive attempts have been made to raise crops on a large commercial scale, first sisal hemp, then rubber, and finally cassava. All have failed, the first because the humidity was too great to dry the fibre satisfactorily, the second because of lack of vertical root space and a devastating leaf disease, and the third because of general expense of labor and constant fertilization. Nature hereabouts gives freely of its riches of gold and diamonds, man may tap the wild rubber trees of the jungle or with effort carry off a few mighty boles to be sawn into lumber, but as yet she suffers no permanent replacement of her primeval jungle with plants of man's domesticating.

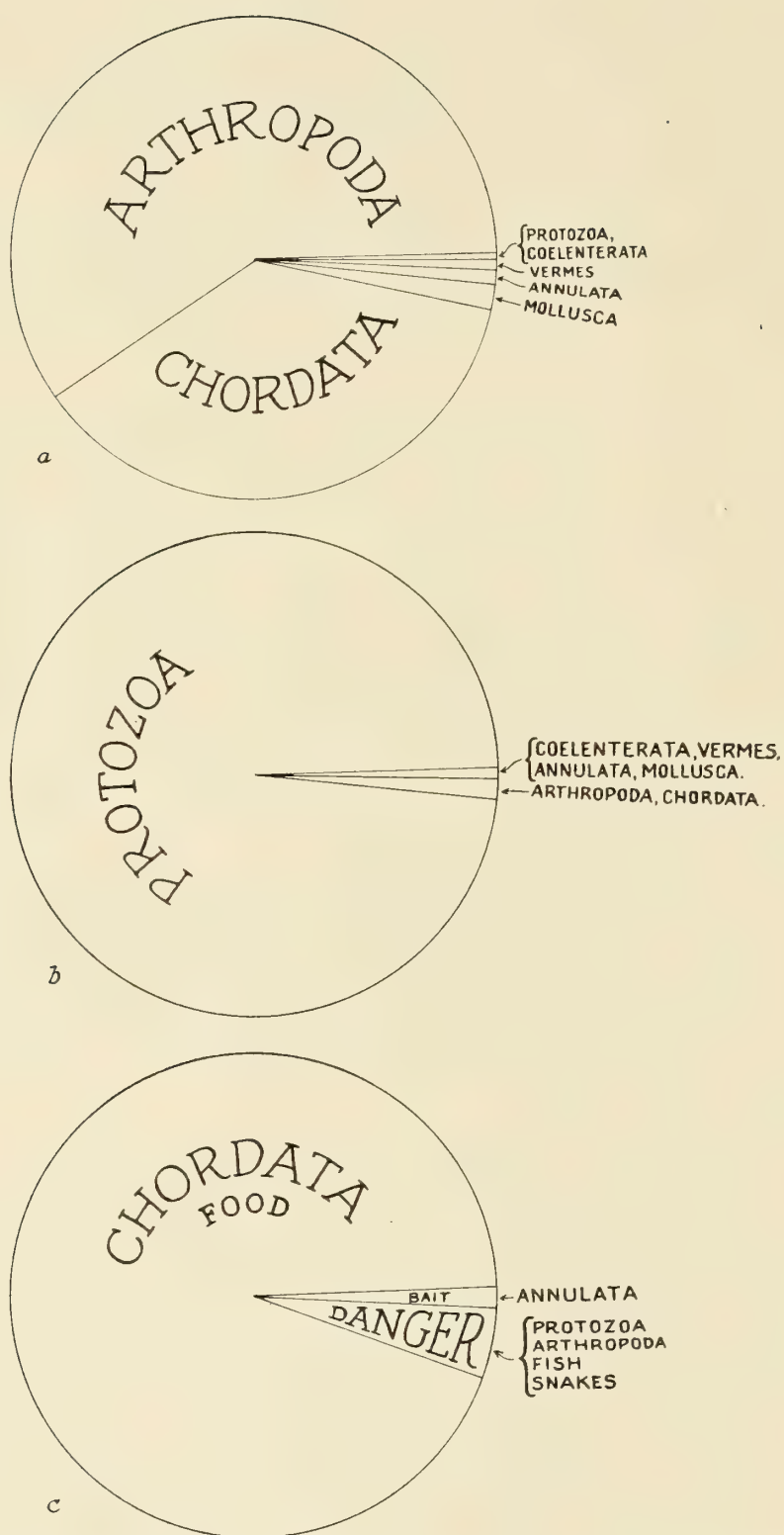


Fig. 8.—a, Apparent relative abundance of Kartabo Phyla. b, Actual relative abundance of Kartabo Phyla. c, Relation of Kartabo Phyla to human life.

VI—THE FAUNA OF KARTABO

Foreword

My treatment, in the present paper, of the fauna of the quarter of a square mile at Kartabo is of the most general character, intended as a preliminary skeleton framework for the more detailed ecological papers and monographs to follow. In addition it will serve to answer some of the numerous inquiries which I receive, relating to the presence or relative abundance of some family or other of organisms. In the case of the vertebrates I have included more detailed accounts of the interrelations in regard to food.

Taking into consideration the fact that most of the groups of organisms have not yet been worked up, nor the innumerable new species been named, I have thought it best, in treating of them, to make use of the simplest, most conservative of classifications.

As almost no two writers use our English terms of occurrence with the same meanings or relative values, I submit my own interpretation of the five relative terms:

Terms of Occurrence

Abundant—To be seen every day and on every walk.

Common—To be found whenever searched for.

Occasional—Uncommon.

Rare—Observed but seldom.

Unique—Recorded but once from the Research Area.

Probable—Present in numbers just outside the Research Area.

Phyla of the Animal Kingdom Found at Kartabo

I—Protozoa	VII—Molluscoida
II—Porifera	VIII—(Echinodermata)
III—Coelenterata	IX—Annulata
IV—Platyhelminthes	X—Mollusca
V—Nematelminthes	XI—Arthropoda
VI—Trochelminthes	XII—Chordata

Admitting these twelve Phyla in the Animal Kingdom, eleven are found within the zone of research at Kartabo. The missing one is Echinodermata, and while we are many miles from salt water, it was rather interesting and amusing to come across remains of sea urchins and starfish near the shore a few yards from

the laboratory. Unfortunately for our summary of living forms, however, these specimens of Echinoderms were in blocks of coral brought as ballast two or three centuries ago by Dutch sailing ships from some distant salt-water port. Here they were dumped overboard to make room for cargoes of sugar and letter-wood.

On this tiny portion of the earth's surface, this quarter of a mile of jungle and water, the animal life is quite undisturbed by man, and just as it has evolved through the ages. To unaided human vision, backed by enthusiastic interest, two phyla occupy about nineteen-twentieths of the entire animal life. With criteria of size and visibility we must represent the Kartabo fauna as in the adjoining Fig. 8, *a*. With actual number of individuals as guide the animal life would be rearranged as in *b*. Again, when the fauna is considered in its relation to the life of the native Indian, or in the case of our own physical life, it assumes a very different phase, illustrated in *c*.

One Hour of Jungle Life

The dearth of life and the silence in the tropical jungle is emphasized and reiterated in book after book of travel, and as long as the observer is actually travelling, he will indeed see little more than the few frightened creatures which rush from his path. When he is content quite to cease being a traveller, and become a stander, or sitter or squatter, the wealth of tropical life begins to be apparent. Even the patient digger or grubber will reap a rich harvest, as when once I searched and found a thousand living beings in a square yard of jungle floor.

Movement, not conspicuous clothing or human form, is the disturbing factor which drives a host of creatures into hiding just before the eyes can detect them, and makes a walk through a primeval forest often a disappointing experience. This can be mitigated by slow movements and intensive observation, and the following is the record of a walk within the research area, west from the Tropical Research Station at Kartabo, back along the Puruni Trail, from 7:30 to 8:30, on the morning of March 26, 1922. There was no wind; the first fifteen minutes were cloudy, while the sun shone brightly the remainder of the time.

I went slowly, making notes as I walked, for forty-five minutes. The last quarter of an hour I spent motionless in one spot near a deep

gully. Writing as rapidly as possible, with only an occasional glance at my note-book, I recorded every hint of living organism seen or heard, five hundred and thirty-six in all, and made a brief written or mental note about each observation. To this list I have added an occasional identification term to clarify my brief written word. It forms, I think, a satisfactory answer to statements of the paucity of jungle life.

Organisms Observed in Forty-five Minutes Along a Tropical Jungle Trail

Brain-fever Cotinga (*Attila*); heard the note of this beautiful bird as I left the Laboratory clearing at 7:30 A.M.

Kiskadee Tyrant Flycatcher (*Pitangus*) seen and heard.

Chestnut-breasted Seedeater (*Sporophila*) in full song.

Spine-tailed Swifts (*Chaetura*), three flying over.

Small Red Beetle.

Giant Black Orioles (*Ostinops*) three seen and heard, one giving courtship performance.

Cicada, heard south.

Dusky Nighthawk (*Caprimulgus*) flying up from trail; a true jungle bird, often perching on high limbs of trees.

Red-backed Caciques (*Cacicus*), two flying toward their nesting trees up the Mazaruni.

Green Trogon (*Trogon strigilatus*) heard giving its breeding song.

Black Cuckoo (*Crotophaga*) heard, whaleep! whaleep!

Small Green Caterpillar.

Green, Long-legged Fly (*Dolichopodidae*) walking swiftly about on leaf.

Small, Black Ichneumon-Fly searching for spiders.

Green Tree Snake (*Oxybelis*) moving slowly through branches.

Large, Brown Cricket (*Eneopterides*) chirping with its vibrating wings.

Green Membracids, eight of these attended by ants on a weed stem.

Small Brown Ants, three running on ground.

Green Dwarf Woodpecker (*Picumnus undulatus*) hammering at an insect's cocoon in a rolled-up leaf.

Small Brown Robber Fly (*Asilidae*) eating prey on leaf.

Blackish Birds, two, unidentified, flying through jungle.

Silver-beaked Tanagers (*Ramphocelus*) two in tree tops.

Yellow-lined Grasshopper, a clearing species, rather out of place in the forest.

Wax-covered Coccids, a group attended by ants.

Large Blue Hunting Wasp (*Pompilid*) half flying, half walking over leaves.

Antbirds (*Formicariidae*), three, unidentified, in dense foliage.

Small Metallic Fly (*Volucella*) on leaf.

Land Crab (*Cardisoma*) scuttling into underbrush.

Metallic Flies, three more.

Giant Green Grasshopper (*Acrididae*) crawling up tree trunk.

Jungle Pigeons (*Leptoptila rufaxilla*), two males calling loudly from neighboring trees.

Organisms observed—continued

- Red Ants, four on guard with jaws raised, on leaf.
Small Brown Cricket.
Rufous Hermit Hummingbird (*Phaethornis ruber*) flying across trail.
Small Brown Weevil.
White-spotted Membracids, three in a row along stem.
Caterpillar of black papilio butterfly (*Papilio*).
Cicada calling, different species from other heard seven minutes before.
Guiana Motmots (*Momotus momota*), three perching in berry tree, swinging their tails from side to side.
Small Brown Grasshoppers, two on leaves.
Large Green Katydid on under side of leaf.
Small White-Spotted Beetle (*Chrysomelidae*) on leaf.
Turquoise-Winged Weevil.
Green-and-Black Chalcid Wasp, very small, searching under leaves.
Black-faced Frogs (*Leptodactylus mystacinus*) two in a small pit.
Green Ground Lizard (*Ameiva*), large male in pit.
Cayenne Hermit Hummingbird (*Phaethornis superciliosus*) squeaking among some flowers in a tree-top.
Robber Flies (*Asilidae*) two large, hairy individuals, mating.
Oblique-Striped Jungle Lizard (*Anolis*) scurrying over leaves.
Medium Metallic Bee (*Euglossa*) hovering close to ground.
Carrion Flies, twenty-four, of five species, around dead frog.
Land Minnows (*Rivulus stagnatus*) two of these land-traveling fish in a pit dug for trapping frogs.
Wood Roach (*Blattidae*) small brown roach on dead leaf.
Sulphur-and-White-Breasted Toucan (*Ramphastos vitellinus*), calling to the north.
Small Brown Caterpillars grouped together on leaf.
Woodpecker, unidentified, hammering to the south.
Small Gnats, a large cloud hovering overhead.
Quadrille Bird (*Leucolepis musica*) gave its wonderful call close to the trail three times, wholly different each time. Did not see it.
Green Stick Grasshopper (*Tryxalid*) resting in center of leaf.
Giant Black Solitary Ant (*Dinoponera*) walking up tree.
Rufous Hermit Hummingbird flying about my face.
Yellow-winged Deer Fly (*Tabanidae*) alighting on my hand.
Common Ithomiid Butterfly (*Melinea* ?) fluttering slowly along.
Crackling Manakins (*Manacus manacus*), a pair flying across trail.
Small Army Ants, a file passing rapidly over leaves and ground.
Bird-winged Morpho Butterfly (*Morpho menelaus*) zig-zagging rapidly past me up the trail.
Robber Fly with a small wasp in its jaws.
Hump-backed Flies (*Hylomyzidae*) resting on leaves.
Brown Ant on leaf.
Green Spider under leaf.
Ichneumon-Fly with white antennae flying slowly.
Small White-spotted Caterpillar on leaf.
Giant Solitary Ants, three on stem.

Organisms observed—continued

Large Brown Spider in web.

Ichneumon-Fly with yellow, black-spotted wings.

Giant Lineated Woodpecker (*Coepheus lineatus*) flying over in the direction of the bird which had been hammering.

Red Howling Monkeys (*Alouatta*) heard to the southward.

Jungle Pigeons heard in a new direction.

Green Spider devouring green fly.

Small Brown Ants, six on one leaf.

Large Chestnut Bee (*Xylocopa*) half buried in a yellow allamanda blossom.

Minute Gnat flying close to my eye.

Spot-winged Antcreeper (*Sclateria leucostigma*) two in vine near trail.

Carrion Flies and Ants on bird dropping.

Small Green Caterpillar looping along edge of leaf.

Yellow-headed Vulture (*Cathartes urubitinga*) swooping low, close over the trees.

Brown Coccids, many on a branch, attended by ants.

Small Green Buprestid Beetle.

Red-throated Caracara (*Ibycter americanus*) calling with loud raucous screams upon discovering me.

Cinereous Antbird (*Thamnomanes glaucus*) calling just out of sight in the jungle, also annoyed by my presence.

Quadrille Bird, a second individual appearing for a moment.

Ithomiid Butterflies, two alighting on leaves.

Green Wood Roach (*Panchloridae*) on green leaf.

Brown Silk Cocoon with chrysalid moving about inside.

Spiders, two fighting on small web.

Large Antbird, unidentified, flying swiftly across trail.

Callistes, Chlorophanes and Bright Colored Tanagers, eight in tall trees.

Large Red Ant on ground.

Small Black and White Butterfly (*Erycinid*) under leaf.

Small Black Flies, three waving their wings and whirling about on leaf.

Long-horned Grasshopper mimicking daddy-long-legs (captured).

Black Chalcid Wasp attacking pink caterpillar.

Guiana Wood Nymph Hummingbird (*Thalurania*) following me for some distance.

Short-tailed Swift (*Chaetura*) flying over.

Minute Gnats, three on a small flower.

Azteca Ants around suspended nest.

Metallic Jumping Spider with fly on leaf.

Termites or White Ants making tunnel near their nest on tree.

Black-fronted Antbird (*Myrmoderas ferruginea*) giving its teacher-teacher-teacher call near the trail.

White-headed Tayra (*Tayra barbara*) one of these giant weasels rushing down out of a tree and off through the underbrush with a great riot of noise.

Minute, Red-Spotted Spider hanging from strand of silk.

Hump-backed Flies (*Hylomyzidae*), two on leaf mating.

Mottled Spider on huge web (*Argiope*), with two blossoms, but no living prey entangled.

Organisms observed—continued

- Green-winged Macaws (*Ara chloroptera*), calling to the north, and later appearing, flying high overhead.
- Brown Loop Worm with front part of body sticking out from stem like a dead twig.
- Grey Jumping Spiders (*Attidae*) motionless on plant.
- Red Ant on ground.
- Hump-backed Fly.
- Tiny White Moth flying close to ground.
- Large Grey Robber Fly resting on twig.
- Large Species Hump-backed Flies, three on one leaf.
- Turquoise-backed Weevil under leaf.
- Mealy Amazon Parrots (*Amazona farinosa*) two flying from tree with loud screams.
- Pygmy Antbird (*Myrmotherula pygmea*) heard.
- Woodpecker hammering loudly ahead.
- Small Reddish Moth on leaf.
- Small Hump-backed Fly on leaf.
- Olive-backed Ovenbird (*Automolus infuscatus*), two feeding on small tree.
- Woodpeckers, two small ones, too high for identification.
- White-breasted Antwren (*Rhamphocaenus albiventris*) one seen and others heard; this one hanging upside down picking at a leaf.
- Spot-Winged Antbird seen near trail.
- Antbirds, two, unidentified, with the Spot-wing.
- Small Parrots, probably *Urochroma*, flying overhead.
- Red Howling Monkeys, a second band heard far to the west.
- Green Mantis gesticulating on leaf.
- Brown Robber Fly with unidentified prey.
- Brown, Yellow-lined Grasshopper, a tree-top species, on leaf.
- Macaws heard (probably the same birds).
- Membracids shaped like small nuts, eight attended by four ants.
- Coccids attended by minute black ants.
- Membracid with pillar-shaped thorax (collected).
- Small Hump-backed Fly.
- High-arched Membracid on same plant, attended by ant.
- Purple-breasted Cotinga (*Cotinga cotinga*) heard in distance.
- Small Inch-Worm on my sleeve.
- Small Brown Wood-Roaches, two running along trail.
- Crowd of Termites rushing out of their nest accidentally broken open.
- Metallic Carrion Fly on leaf.
- Lace-winged Fly (*Chrysopidae*) resting under leaf.
- Metallic Coppery Scarab Beetle resting on leaf.
- Dancing-Wing Flies (*Trypetidae*), gyrating on a leaf.
- Dumb-Bell-Shaped, Long-Legged Flies flying and on leaf, one elaborately courting the other.
- Small Metallic Green Fly (*Volucella*) on flower.
- Maggots (*Diptera*) thirty or more around a bit of carrion.
- Small Black and White Butterflies (Pierids, although an exact copy of *Heliconids*—genus *Dismorphia*).

Organisms observed—continued

- Small Brown Dragonfly on tip of leaf.
Small Birds, two in tree, not identified.
Yellow-bellied Calliste Tanagers (*Tangara mexicana*) three in tree.
Large Hump-backed Fly.
Yellow-winged Deer Fly buzzing about my face.
Green Spider on green leaf.
Small Metallic Fly.
Small Brown Grasshopper.
Hairy Black Robber Fly.
Termites, small colony of these with snapping jaws.
Muscid Fly on leaf.
Dark Saddle Membracids with four ant attendants.
Golden Metallic Bee.
Four Black Trigonid Bees.
Two Ithomiid Butterflies.
White Flower-like Spider.
Two Volucella Flies.
Slender Black Ant.
Dolichopodid Fly.
Sulphur- and-White-breasted Toucans, a pair calling.
Guiana Motmots calling in their muffled tones ahead.
Small Copper Beetle dropping to the earth at a touch.
Minute White Moth.
Brown, Long-legged Ctenid Spider.
White-antennaed Braconid Wasp.
Small Brown Ants, three carrying a bit of food.
White-crowned Manakin (*Pipra leucocilla*), a male flew past.
Yellow and Black Cercopid Bug (*Tomaspis ruber*).
Minute Metallic Fly.
Brown and Red Caterpillar.
Red-rimmed Black Hemipteron on leaf.
Giant Blue, Tarantula-Killing Wasp.
Three White-crowned Manakins, two males and a female.
 Dusky Parrots (*Pionus fuscus*), three calling from tree overhead.
Woodpeckers hammering, one west, a second south.
White-throated Thrush (*Turdus phaeopygus*), parent and nestling hardly
able to fly, pursued them but could not capture the young one.
Large Rhinoceros Beetle flying past.
Macaws heard, perhaps the same pair seen earlier.
Black-throated Trogon (*Trogonurus curucui*) heard and seen.
Yellow-throated Caracara (*Ibycter ater*), flying out of low tree screaming loudly.
Yellow-headed Vultures, two soaring past.
Small Swift, unidentified.
Small Gold-fronted Hummingbird, unidentified.
Large Jungle Damsel-Fly (*Mecistogaster*) fluttering slowly over the trail.
Small Hump-backed Flies, two on leaves.
Metallic Jumping Spider with small insect.

Organisms observed—continued

Saddle Membracids, eight adults and young, attended by three ants.

Furry Black Caterpillar eating leaf.

Small Robber Flies, two mating.

Tiny Red Caterpillar under rolled leaf.

Walking Stick Insect (*Phasmid*) hanging by four legs from a leaf, the front pair stretched out along the antennae.

Agouti (*Dasyprocta aguti flavescens*) rushing away from a wild plum tree, grunting loudly.

Small White Pierid Butterfly on flower.

Red Howling Monkeys heard, probably the same as the last band.

Cloud of Gnats in mid air.

White-fronted Antbirds (*Pithys albifrons*) three chirping close to trail, all seen.

Antbird, another species seen only for a moment.

*Army Ants (*Eciton burchelli*), a small fan of these ants, accounting for the presence of the antbirds.

Three Wood-Roaches scurried out from among dead leaves.

Two Daddy-Long-Legs hiding among the same leaves.

Large Brown Millipede (*Polydesmid*) crawling on ground.

Small Flies, six hovering over a dead spider.

Two More Wood Roaches.

Harlequin Jungle Cricket (*Rhipipteryx*) flew ahead of me.

White-fronted Antbird, a fourth individual.

Wedge-billed Woodhewer (*Glyphorhynchus cuneatus*) creeping up trunk of tree.

Yellow Chalcid Wasp resting on leaf.

Antbirds, flock of about a dozen in tall tree, unidentified.

Ameiva Lizard, rushing into hole as I approached.

Long-legged Dolichopodid Fly on leaf.

Giant Metallic Blue Bee flying past.

Tryxalid Grasshopper motionless on leaf.

Azteca Ants in nest suspended over trail.

Reached Gully at 8:15 and Observed the Following Organisms within Fifteen Minutes:

Red-fronted Woodpecker (*Tripsurus rubrifrons*) seen and heard hammering almost overhead.

Olive-backed Ovenbird (*Automolus*) seen picking up food from bottom of gully.

Amazon Parrots calling, not seen.

Mouse-Colored Bushbird (*Hypolophus murinus*) calling.

Small Ichneumon-Fly alighting on my hand.

Two Muscid Flies hovering over flower.

Minute Grey Moth flying nearby.

Brown Cricket calling a few feet away.

Palm Tanagers (*Thraupis palmarum*) heard and seen in tree.

Guiana Squirrel (*Guerlinguetus aestuans*) scolding me a minute or more from the center of a bush across the gully.

Organisms observed—continued

Red Howling Monkeys making a great uproar to the north, probably a new band.
Two Small Flies in mid air.
Minute Gnat flying about my eyes.
Macaws again, probably the same pair.
Reddish Robber Fly resting on leaf.
Ring-tailed Monkeys (*Cebus apella apella*) swinging by within fifty feet, passing close to the ground.
Large Ant with the tip of the abdomen jet black.
Trypetid Dancing-wing Fly.
Long-tailed Hummingbird, probably *Phaethornis*, flying swiftly.
Minute Yellow Ants, twenty in small flower.
Deer Fly buzzing close to my face.
Small Yellow Caterpillar under nearest leaf.
Small Ithomiid Butterfly flying slowly past.
Variegated Tinamou (*Crypturus variegatus*) calling to the south.
Papilio Butterfly alighting nearby and walking over leaf.

8:30 A. M.

Summary of Organisms Observed

Within an hour's time I made two hundred and forty-six observations and recorded five hundred and thirty-six living creatures. This included all five phyla of vertebrates, of which one hundred and twenty-eight individuals were birds. The details of this summary are as follows:

	Observations	Individuals
Mammals.....	8	12
Birds.....	71	128
Reptiles.....	4	4
Amphibians.....	1	2
Fishes.....	1	2
Insects:		
Lepidoptera, Imagos.....	13	16
Lepidoptera, Caterpillars.....	11	11
Hymenoptera.....	39	95+
Diptera.....	47	139+
Orthoptera.....	20	25
Hemiptera.....	13	43
Coleoptera.....	9	9
Odonata.....	2	2
Isoptera.....	3	30+
Spiders.....	11	13
Phalangida.....	1	3
Millipedes.....	1	1
Crabs.....	1	1
	246	536

PHYLUM I—PROTOZOA

To write of the single-celled animals of a locality is like considering the snow crystals of Greenland or the sand grains of Kartabo beach. My Indians know nothing of their existence, yet they help to make his benab livable, they compel him to cook his game almost at once, and in the end they usually kill him.

Even we who in the past have studied them and watched their successive generations, who can give names to some, and predict their haunts and reactions, almost never think of them until an injury becomes infected, or until the clear water of an aquarium changes to opacity in a few days. Unarmed with a microscope we would admit Protozoa to but small part in the fauna.

In an aquarium on my table one day were several armored catfish, and a floating leaf of a tropical water weed. Within a week the water became green and opaque, but without slime or odor. I found that it was almost a pure culture of the green flagellate *Chlamydomonas*, with a scattering of *Vorticella*. I estimated the number of large drops in the six thousand cubic centimetres of the aquarium at one hundred and twenty thousand. A greatly underestimated count of these green-shelled flagellates gives one hundred thousand to a drop of water, spread over a cover-glass. Another calculation, and I look at the aquarium with awe, for at the lowest estimate it contains twelve billion *Chlamydomonas*—all active, kicking themselves about with their several flagella, busily dividing into more billions and incidentally furnishing the five large catfish with the where-withal, apparently both oxygen and nourishment, for three months of undisturbed existence in this aquarium.

Observations on Protozoa have all been incidental to other work, but some general facts have been recorded. Of the three habitats, river plankton, swamp-mud and water, and the water in bromeliads, the last has proved to be by far the richest in microscopical life of all kinds.

Four Classes of Protozoa are recognized:

Class I—Sarcodina

Class III—Sporozoa

Class II—Mastigophora

Class IV—Infusoria

All of these are represented in the Kartabo fauna.

Class I—SARCODINA

Amoebae of several species and *Arcella*, the latter occasionally

in great numbers, abound in mangrove bromeliads; *Diffugia* has been found both on debris in Mazaruni current-moved plankton, and in deep swamp pools; *Actinophrys*, or a closely related form, occurs in plankton.

Class II—MASTIGOPHORA

Euglena, *Ceratium* and *Volvox* in bromeliads; *Chlamydomonas* and many other forms of this Class both in bromeliad and swamp water. *Gonium* is one of the most interesting of this group, the few cells clinging together with just sufficient definition of arrangement and division of labor, to adumbrate Metazoa.

Class III—SPOROZOA

Plasmodium is occasionally brought in the blood from Georgetown and other parts of the coast, but there is no indigenous malaria at Kartabo, owing to the complete absence of mosquito carriers.

Class IV—INFUSORIA

Paramoecium is common in bromeliads; *Stentor* has been dredged in Mazaruni mud, and found growing on the eggs of the small, surface-swimming minnow *Tomeurus*; *Vorticella* occurs commonly in infusions, in mid-river plankton, on fresh-water sponges below low tide mark one hundred feet from shore, and has been observed in good-sized colonies near the gill openings of healthy tadpoles of *Lepidodactylus rhodomystax*.

Almost as common as *Vorticella*, in plankton, are colonies of *Epistylis*, but decidedly rare are the beautiful little sessile, cupped *Cothurnia*. *Opalina*, of several species, are common parasites of Amphibia.

PHYLUM II—PORIFERA

This phylum plays one of the smallest parts in the fauna of Kartabo. It is of great interest, however, in being one of the marine invaders of this fresh-water region—pioneers from the great oceanic fauna of sponges.

Class I—DESMOSPONGIAE

Family SPONGILLIDAE

The presence of fresh-water sponges is evident from any slide of plankton or river-mud debris, spicules being almost always visible,

mingled with the desmids and diatoms. Living sponges are not uncommon on disintegrating rock a hundred yards off the Laboratory beach, about a foot below low tide level. The rocks show colonies two to four inches in diameter, masses of spicules rising in glassy clusters like some strange crystals above the surface of the stone, the lower, living portion being covered with a thin, green veil of tissue. The spicules are very uniform, simple, smooth, transparent, slightly curved, blunt, almost truncate, thick and uniform in thickness throughout their length: they average .4 mm. long by .05 mm. in diameter.

Star-shaped spicules with six rays, and simple spicules with lateral irregularities are also found now and then in plankton.

Quite another type of sponge coats the under side of stones in one or two streams in the research area and especially in swift-flowing side streams of the Cuyuni above the first rapids. It is like a brown moss in life, and the spicules are very slender, simple, smooth, curved and needle-pointed at both ends, reaching an extreme length of 1 mm.

PHYLUM III—COELENTERATA

This is probably the least important Phylum in the research area, and as with Porifera, is an example of marine invasion. Both among the plants of *Victoria regia* and in the water of jungle creeks, I am always on the lookout for the fresh-water free-swimming medusa *Lymnocodium*, but have never found it.

Class I—HYDROZOA

Several times I have detected hydras, both green and brown, in bromeliad water, and twice a long tentacled form appeared in plankton debris from mid-river.

PHYLUM IV—PLATYHELMINTHES

Flatworms are common organisms in the research area, and few fallen logs are without one or more of the larger forms while as internal parasites they are less numerous. All four Classes are represented.

Class I—TURBELLARIA

The Kartabo Turbellarians or Land Flatworms are truly tropical in size and colors. Their habitat is rotten logs and dead bark, or less frequently the under side of moist jungle leaves. Some attain

a length of three inches. They may be leaf brown, with delicate shadings of darker along the edge, or mottled like lichens, or marbled grey and white, or with pink and black like the brevicipitid frog *Atelopus*. There is occasionally remarkable mimicry or at least a pattern paralleling that of slugs living in the same environment.

Class II—TREMATODES

Doubtless abundant, but I have observed them chiefly as parasites in fish; forms closely resembling *Cotylaspis* occurring in the gills, together with others quite unlike any usual type of fluke.

Class III—CESTODES

Tape-worms do not seem to be very abundant. Although no special search has been made for them they have been observed in all groups of vertebrates.

Class IV—NEMERTEA

A few small Geonemertean-like worms have been examined, living in decayed wood near the shore.

PHYLUM V—NEMATELMINTHES

Two Classes of Round Worms are present in the fauna of the research area.

Class I—NEMATODA

Parasitic round worms exist in enormous numbers as internal parasites in all groups from Arthropods to Mammals. Sometimes, as in the snakes of the genus *Xenodon*, large balls of hundreds of full-grown Nematodes are found in the intestine. A small round worm appeared under the skin of the instep of one of our members and lived for a week, moving slowly about until killed.

Filaria occurs as a parasite in the blood of most of the Indians and Bovianders or half-breeds who come to the station. It does not develop as elephantiasis as often as on the coast.

Class II—GORDIACEA

Hair worms are occasionally seen when dissecting insects, and several times dark brown ones, eighteen inches or more in length, have been caught in the water of the jungle creeks.

Class III—ACANTHOCEPHALA

These rotifer-like worms are common in the stomach and intestines of various fishes. A straight, oval form in *Pimelodus*, and a curved species in six or seven wholly unrelated types of fishes are both members of the family Echinorhynchidae.

PHYLUM VI—TROCHELMINTHES

Class I—ROTIFERA

Rotifers are abundant in all suitable places, infusions, creeks and river water, in isolated jungle pools and especially in bromeliads. Some are most remarkable forms and would well repay intensive study.

PHYLUM VII—BRYOZOA

Small colonies of *Plumatella* have been found in widely separated pools in the jungle, but this is one of the most poorly represented of all eleven phyla.

PHYLUM IX—ANNULATA

The true worms are represented by two Classes, the two remaining ones being altogether marine.

Class I—CHAETOPODA

Order I—POLYCHAETA

One of the greatest surprises of the Kartabo fauna was to find examples of this marine Order, so far beyond the reach not only of salt but even brackish water. When digging worms for bait in sandy mud close to the shore in H₃, in an area which is covered with water at high tide, Nereis worms were uncovered. When a six-inch individual was cut in half accidentally, a new head was regenerated in a few weeks at the front end of the posterior half. In 1919 in this extremely limited locality the worms were found to be fairly common. Two years later not a single individual could be found. They represent a new species.

Order II—OLIGOCHAETA

The Oligochaete fauna is a rich one at Kartabo; many species are common in plankton, in quiet jungle pools and swamps, and especially in bromeliad water. Very remarkable oligochaetes are occasionally seen in the latter environment.

Lumbricidae or earth worms are abundant both as to species and individuals. I have seen giants three feet in length living in swamp soil, while in every fallen log and under dead bark often high up in trees are small, scarlet, intensely active angle worms.

Class II—HIRUDINEA

One of the greatest distinctions between the jungles of Kartabo and those of the Eastern tropics is the total absence of land leeches in the former place. They are never seen on leaves or twigs, and for that matter are rare in any environment. Small ones are occasionally found in the water of creeks, and minute individuals in the gills of tadpoles and fish.

A large, five-inch, blood-red leech was once taken in mud. It showed little sign of external segmentation and had an extremely flattened head. After an hour in clear water it was found broken up into many small pieces, and had extruded a large Nematode.

PHYLUM X—MOLLUSCA

Although the Mollusca of the Neotropical Region are, as a whole, exceedingly abundant, this is not the case at the Kartabo Research Station. Whether due to the lack of lime or other cause, snails and slugs are far from numerous, especially as regards species. The group has not yet been worked up, but there are probably not more than twenty species altogether.

All but one of these are Gasteropods, of which about one-fifth are Prosobranchs, and the remainder Pulmonates.

An unnamed species of *Helicina* is found on the leaves of low jungle growths. This small, hairy form is an air-breathing Prosobranch. A giant banded *Ampullarius* is locally common in shallow water and near the coast forms the chief food of the hawk, whose beak seems formed especially for extracting the inmate from its curved shell. Clusters of greenish eggs of this snail are often seen on the stems of the mucka-mucka.

The giant among mollusks is *Orthalicus sultana*, extremes being four or even five inches in length, and conspicuously clouded and banded. Once during a short dry season, a large snail of this species aestivated on a beam at one side of the laboratory entrance, and we used it as a living knocker, beating a rat-tat-tat with the shell day after day without disturbing the hibernating occupant.

A new subspecies of *Auris distaeta* lives on leaves, sometimes

high up in the jungle. The most brilliant snail of this region is an unnamed *Corona*, with markings of yellow, brick red, grey and white.

Several species of large slugs of the genus *Veronicella* occur, brown or black in color, and are eaten by *Bufo marinus* and *Leptog-nathus variegata*.

On a few half-exposed rocks in mid-river are found a few bivalves, small fresh-water unios, probably of the genus *Saxicava*, the only representatives of this great group.

Mollusca is decidedly not a conspicuous or important phylum in this area of British Guiana.

Phylum XI—ARTHROPODA

Class I—CRUSTACEA

Crustaceans are in constant evidence along the tidal area, but inland they are seen only occasionally, in the shape of land crabs, or smaller types hidden within decayed wood.

Subclass I—ENTOMOSTRACA

All the Orders of this group except the barnacles (*Cirripedia*) are represented at Kartabo.

Order I—PHYLLOPODA

Among many others, *Daphnia*- and *Bosmina*-like forms are abundant in river plankton. I have found eighty-two individuals of the former in the stomach of *Tomeurus*, a surface-feeding minnow, less than half an inch in length.

Order II—COPEPODA

Cyclops and related genera occur in jungle pools and also in bromeliads. In river plankton their perfect, cast skins are present in enormous numbers, and the living animals are sometimes so abundant as to appear like a fine milky precipitate.

Strange parasitic forms of *Argulus* occur in several species and in various places, such as the tails of tadpoles and in the mouths of Perai fish. An undescribed species of *Dolops* lives on big six-foot catfish.

Order III—OSTRACODA

Cypris and another closely related form occur in bromeliads.

Subclass II—MALACOSTRACA

DIVISION I—ARTHROSTRACA

Order I—AMPHIPODA

Gammarus-like forms have been observed on three occasions but none collected.

Order II—ISOPODA

Parasitic Isopods are abundant, Cymothoidae on the gills of *Pimelodus* and other small catfish, and Bopyridae within the gill-covers of shrimps. This latter, a species of *Probopyrus*, is present on either the right or left side in twenty percent of the adult shrimps.

Sowbugs and pillbugs are abundant in the research area, under bark and in the wood of decayed fallen logs. The species are numerous. Small, dark-mottled Oniscidae, allied to *Philoscia* and *Porcellio* live under bark. I have found as many as seven in the stomach of a *Dendrobates* frog. Larger, dark-banded forms, fifteen millimetres long, with scarlet head and antennae, prefer moist leaves on the jungle floor as well as rotten wood. They belong to the marine family Ligydidae.

Armadillidae-like forms, rolling into perfect balls at the slightest hint of danger, live under bark.

At least eight species of Isopods have been collected in the quarter of a square mile, of which four are undescribed.

DIVISION II—THORACOSTRACA

Order I—DECAPODA

Suborder A—MACRURA

While there are doubtless many species of shrimps, the most abundant of the river shallows is *Palaemon amazonicus* Heller. It occurs in great numbers and is caught and used as bait by the Indians. Small, split bamboo traps called *mahswas* are used expressly for this purpose. Smaller species are found far up in the jungle creeks. The river shrimps are omnivorous and scavengers, being attracted by various jungle seeds, dough, termite nests, or old fish and meat. A giant species, lobster-like in size, of the family Atyidae is much rarer. It is rich brown in color, striped with yellow and buff with delicate blue mouth parts.

Suborder B—BRACHYRUA

Several forms of crabs are not uncommon and one is abundant. The small mangrove crab lives in large numbers in the crevices of rocks, under stones and in the pockets of tree buttresses. Its favorite haunt is the mangrove roots up which it climbs for many feet.

One specimen weighed 2.1 grams, was 16 mm. between the eyes, and had been feeding on vegetable debris and small insects. There is great variation in color, the general tone being neutral, like the mossy or lichened or muddy mangrove roots, the chelae being dull yellow.

Large land crabs are found near the shore in the dry season and several miles inland during the rains. They are handsome crustaceans with the legs brilliant scarlet, the claws yellow, and the carapace purplish-black, bordered with pale yellow.

A female had eight young in her caudal sac on May 10. They were 10 mm. across the carapace. She was of large size with her chelae stretching laterally 200 mm. Her carapace was mahogany-colored, exactly like a mora seed.

Nine species of birds have been found feeding on crabs.

Class II—ARACHNOIDEA

Of the ten Orders of this Class, I have found seven at Kartabo. The Palpigradi have not yet been found although they are known to occur both in Paraguay and Texas; Solpugi have escaped notice although this is within their range, and I have detected no Linguatulid. These latter have been found in an autochthonous family of fish, so that all the groups are probably represented.

Order I—SCORPIONIDA

Scorpions are common under bark and in old rotten logs, but very rarely seen about the laboratory. Two families are most abundantly represented; Chactidae, to which the majority of the individuals belong, with thick, short chelae and two lateral eyes, and Buthidae, less common, with slender thin chelae and three lateral eyes. They breed during the rainy season and it is not uncommon to find a mother scorpion with ten to twenty pale colored young riding on her back.

I have been stung once and three of my staff have at various

times had the experience which is like that of the sting of a medium-sized wasp. Twice I have seen these creatures striving to defend themselves against the attacks of army ants (*Eciton*), by picking the ants off one by one, with their claws, but this sort of defense is useless against these terrible insects, and again and again the ants are seen carrying the segments and even the sting of small scorpions.

Order III—PEDIPALPI

Whip scorpions are rather uncommon; found in much the same places as scorpions, with a preference for over-shot banks and the hollows of trees. A pair which crawled out of a deep hollow when a purple-heart tree was cut down were very large, the whips of the male spreading twenty-three inches. These belonged to the family Tarantulidae.

Very small, tailed whip scorpions of the family Shizonotidae live in rotten wood. In six months of constant searching for termite nests in logs, one of my staff captured ten and saw about fifty.

Order V—PSEUDOSCORPIONIDA

Family CHELIFERIDAE

Members of the genus *Chelifer* are common in rotten logs, fifty or sixty having been seen in a day. *Chelanops* and closely related genera are rarer, and usually under loose bark. Single large specimens have been taken clinging to longicorn beetles and to common bats (*Molossus*), but usually these creatures are found on their volant hosts in pairs.

Obisium of the family Obisiidae has been found only in the stomach of a *Dendrobates* frog.

Order VI—PHALANGIDA

Harvestmen or daddy-long-legs are very abundant both as to species and individuals, more especially on the edge of glades and clearings and on the upper beaches. They spend the day under leaves and come out at dusk. They sometimes gather in large moss-like masses. Their principal diet inland is dead insects, droppings and half-rotten fruit, but the beach forms are aggressively carnivorous, and kill and devour ants, crickets and newly emerged dragonflies. Many superficially resemble our northern harvestmen, others are large and more brilliantly colored.

They seem unusually immune from molestation, as I have detected their remains in the stomachs of only three vertebrates, *Bufo marinus*, that most omnivorous of amphibians, and of two birds, one a cuckoo, *Crotophaga ani*, and the other an antbird, *Sclateria naevia*.

Order VII—ARANEAE

Spiders perhaps lead the Arthropoda in point of species, and are second only to the ants and termites in actual numbers. They are as inconspicuous as the ants are dominantly visible, but a few seconds with a sweep net, or an examination of under foliage, or rolled leaves, reveals the enormous numbers of these creatures.

Some fashion individual webs of great beauty, while others build communal webs extending over many square yards and forming excellent collecting places, where many interesting insects become entangled. Leaping spiders hunt down their prey, flower spiders bite out parts of blossoms and sit in the gap, simulating the lost petals, small tarantulas nest in curled up leaves or build subterranean trap-door tunnels in the laboratory compound, others of the largest size inhabit the roof of the Station bungalow, and vie with us in hunting insects attracted to the lights. The variety of habits, forms, patterns and colors of spiders is endless and the group would form a splendid subject for research.

They occupy a midway position in the life and death struggle of these tropics—feeding on living prey of many kinds, and being themselves the sole food of hundreds of species of organisms. With thousands of hymenoptera hunting every leaf and twig to store their cells and caves, and with flocks of hungry birds and scores of lizards searching for food every hour of daylight, it is a wonder that these soft-bodied creatures can keep from extermination.

Besides their many Arthropod enemies I have found spiders in the stomachs of two fish, three amphibians, four reptiles, one mammal and no fewer than fifty-three species of birds.

Order VIII—ACARINA

Mites are exceedingly abundant, being found on all sorts of hosts and in every conceivable environment. Unattached ticks are rare in the jungle and it is seldom that I see more than one a week. The scavenger mites, Gamasidae, are found on many hosts, weevils being the commonest. Large-sized ticks, Ixodidae, are found singly

on snakes, lizards, amphibians and mammals, and very rarely on birds.

Harvest mites, Trombidiidae, locally known as *bête rouge*, are troublesome at times and places, especially in grass, although I have never known them to be as bad as on Long Island and the Virginian coast. They persist throughout the year, but are more abundant, or at least more irritating, in the dry seasons. The human blood seems to develop an immunity to the irritation of these mites, and after a few weeks their presence is seldom noticed. Almost every individual mammal, bird and land reptile is infested with these pests, usually in the form of clusters on various parts of the head.

A very few birds and lizards feed on mites, and the very tiny, newly-emerged *Bufo marinus* often make them their chief food.

Order X—TARDIGRADA

Two water-bears have been observed in a slide of water from mangrove bromeliads.

Class III—TRACHEATA

DIVISION I—ONYCHOPHORA

Peripatus is not rare when searched for in rotten logs, both in deep jungle and in clearings. Three were found in a certain rotten log lying out in full sunlight in the laboratory clearing, and two more in the same place a year later.

I have collected five back of the laboratory in the open clearing among the stems and roots of short grass, where there were no logs or wood of any kind, and very little protection from the sun's direct rays. They live well under damp bark, and I have had as many as eight young born from a single female.

DIVISION II—MYRIAPODA

Millipedes and centipedes are common, some of the former abundant, climbing up the trunks of trees, under bits of loose bark and in rotten logs; centipedes in dryer places, rarely in tents and dwellings. The bite of one of the twelve-inch centipedes would doubtless be very unpleasant, but certainly not dangerous if treated.

Millipedes would seem but indifferent food, yet many organisms choose them. Among others, millipedes are eaten by black cuckoos, *Crotophaga*, by *Thamnophilus* and *Formicarius* among antbirds,

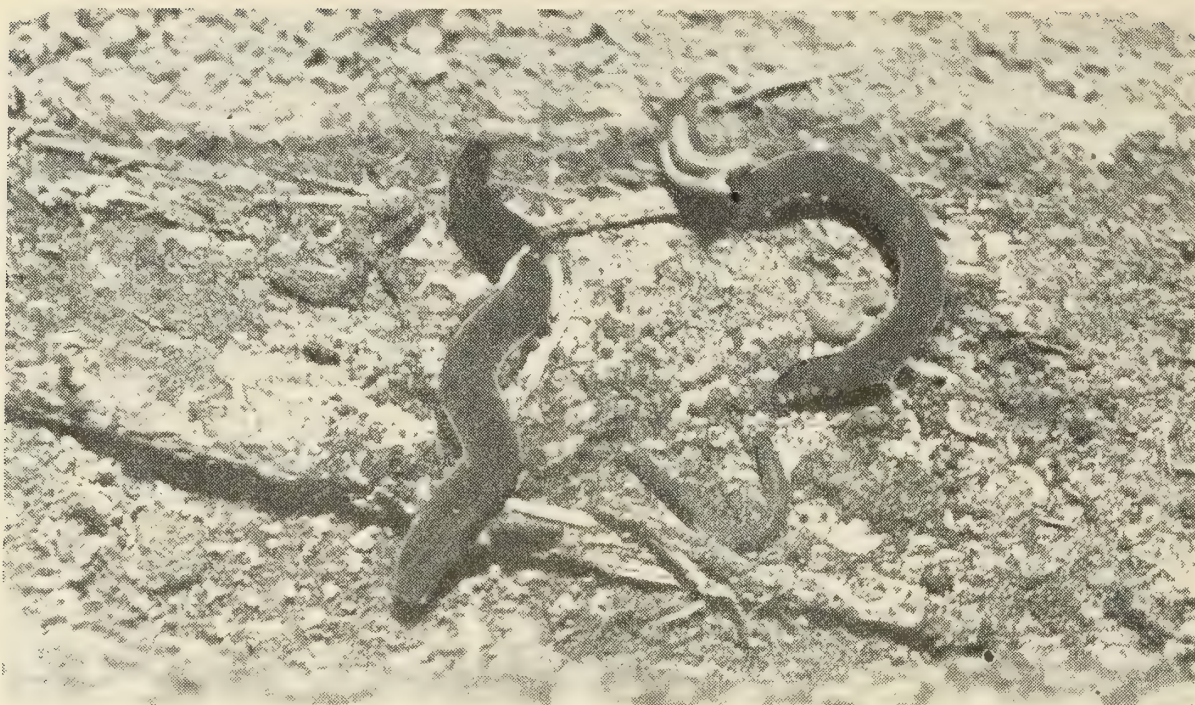


Fig. 9. *Peripatus*; one of the most primitive of Arthropods.
It is viviparous, and three newly born young are seen in this picture.
Photograph by John Tee-Van.

Xiphorhynchus and *Dendrocolaptes* among woodhewers, besides *Bufo marinus*, *Dendrobates*, *Ameiva* and *Plica*. Centipedes fall victims to the same species of birds with the addition of the hawk, *Leucopternis*, the antbird *Hyloperxus*, and a jay *Cyanocorax*, in addition to *Bufo typhonius*, anolis lizards and the mammal coatimundi, *Nasua*.

Small, many-segmented, dark-colored millipedes of the family Julidae with eyes in clusters are fairly common and are eaten by *Ameiva* lizards, but by far the most abundant millipedes are the big brown Polydesmids, on trees, in fallen logs and under bark. There are nineteen body segments, they are two to three inches long, and roll up at a touch. When annoyed they exude an ill-smelling brown liquid, and are altogether forbidding as food, yet the insatiable *Bufo marinus* seem to enjoy them.

Giant centipedes with twenty-one segments, *Scolopendra*, are found occasionally, the largest so far being thirteen inches long. Two nine-inch ones were taken in a tent and a smaller individual was seen on a lofty dead branch feeding on a buprestid beetle. In the low jungle these are replaced by small ones, of twenty-three segments, with long, whip-like hind legs; all, however, are decidedly uncommon. Notophilidae and Geophilidae are represented by small-sized centipedes in rotten logs and on jungle debris.

DIVISION III—INSECTA

It would be indeed a rash thing to attempt an adequate survey of the insect life of even this quarter square mile of tropical jungle. Our present knowledge of it is most fragmentary, but sufficient to indicate the general relative abundance of the various groups and to reveal the dimensions of this extraordinary field of research. Together with birds, the insects assuredly hold the position of dominant organisms of the present day at Kartabo.

EVERY ORDER OF INSECT IS REPRESENTED AT KARTABO

I—Thysanura	XIII—Parasitica
II—Orthoptera	XIV—Thysanoptera
III—Isoptera	XV—Neuroptera
IV—Euplexoptera	XVI—Mecoptera
V—Mallophaga	XVII—Trichoptera
VI—Corrodentia	XVIII—Lepidoptera
VII—Zoraptera	XIX—Coleoptera
VIII—Plecoptera	XX—Strepsiptera
IX—Ephemera	XXI—Diptera
X—Odonata	XXII—Siphonoptera
XI—Hemiptera	XXIII—Hymenoptera
XII—Homoptera	

Order I—THYSANURA

Suborder I—CINURA

These lowly insects are abundant, no rotten log or mass of dead leaves being free from so-called fish-moths. They are free living, many as long as eight or ten millimetres, usually pale yellow, and very active, scurrying about the porous wood, and so delicate that they are very difficult to capture without damaging antennae or cerci. Smaller, translucent green forms are found in myriads on the under surfaces of leaves and still others such as *Atelura* are termitophilous or found associated with ants. *Nicoletia* is also not uncommon.

Suborder II—COLLEMBOLA

Collembola are less numerous than Thysanura, but occur in much the same places. One of the most remarkable forms is a little creature of a wrinkled, velvety indigo color, with a reduced springing apparatus. Others, Poduridae, are abundant not only on

rotten wood but in the debris of the upper beach, where they gather at night in hundreds about half-rotten fruit or other organic flotsam and jetsam. *Borecus pinnatus* is very abundant in termite nests. One group of tiny wasps, *Microstigmus*, stock their hanging, bell-like nests with nothing but spring-tails.

Order II—ORTHOPTERA

Family BLATTIDAE

The common roaches of the bungalow are wide-spread species of *Periplaneta* and *Pycnoscelus* which, until we encouraged tarantulas and geckos, gnawed our clothes and books, and destroyed all insect specimens which were not kept on swinging shelves.

In the jungle, roaches outnumber all the other Orthoptera, occurring chiefly among fallen leaves and debris, but as they enter into the food of many tree-climbing and leaf-searching birds, they must be almost universal in their love of hiding places. At least a score of species may be called abundant or common.

Family MANTIDAE

Egg-cases, newly hatched broods and full-grown mantids occur everywhere that green leaves are found, but they are common rather than abundant. The majority of the species are brown, but others are green, with sometimes discolored or transparent spots. Some are ornamented with brilliantly colored ocelli and other patterns, while the flower mantids vie with any orchid in coloration.

These insects are readily kept alive for months, exhibiting interesting feeding habits, now and then depositing a mass of eggs, and becoming quite tame. Two lizards and at least five species of birds include mantids in their diet.

Many jungle forms fly to our lamps at night. Over twenty-one well-known species have been taken, besides many still undescribed.

Family PHASMIDAE

It is in this family that tropical Orthoptera reach their most bizarre development. On the leaves and branches of low bushes in clearings, in mid-jungle and on the foliage of trees which are chopped down, are found walking sticks, minute, medium, and occasional giants eleven inches long. Some are smooth and enamelled, others roughened, or with foliaceous excrescences: wingless, or with tiny parodies of wings, or fully functional expanded membranes: and

finally insects which appear to be nothing but animated green, veined leaves.

When the wings are too small to fly with, they often function as flash organs. A stick insect will suddenly snap open a sheet of brilliant yellow and scarlet, the colors shooting out from an apparently dead twig, in the most startling manner.

These insects have learned to support themselves on three or four legs, and to dangle the remainder in midair; they also sway when disturbed, as if a breeze were moving them. They do not do well in captivity.

Family ACRIDIIDAE

The short-horned grasshoppers are first among the families of Orthoptera in numbers, and they swarm in every open glade, and especially in clearings. They fly up at every step and their flight is directed invariably toward or into the shelter of the denser jungle. About thirty species are common.

Tribe TETTIGIDES

Ten species of the little tettix hoppers, with solid dorsal armor, are common and found almost exclusively on the trunks of dead or fallen trees. They are remarkably like the hue of their particular trunk, and within fifteen feet I have found a brood of very dark tettix on a dark-barked trunk, and pale, mottled ones on a tree covered with parti-colored lichens.

Tribe TRYXALIDES

These stick grasshoppers are such good imitations of dead twigs that they choose to rest quietly on branches quite exposed throughout the day, waiting for night to come. Or if they become too hungry, they begin eating the edge of leaves with very slow and deliberate movements, scarcely to be distinguished from the motion of the leaf on which they rest. Head, body, antennae, legs, all are twiggy, and so completely do they trust to their invisibility that they may be picked up without careful approach. They are common but never abundant.

Tribe ACRIDIIDES

As in northern lands, these "meadow" grasshoppers are the dominant form of Orthoptera. As members of the same tribe we must count the tropical giants which reach a length of six inches,

whose wings when spread in flight are as large as those of a good-sized bird, and more brilliant than many. These insects prefer the edge of the jungle and clearings.

Another large form is clad in a livery of scarlet and black, and the wingless mynphs appear in a solid phalanx of one or two hundred, travelling steadily through the jungle or across a grassy clearing, walking slowly, and hopping only when frightened. They show no fear of birds or lizards, and although anis eat them, and an occasional one is found in an *Ameiva*'s stomach, they flaunt their brilliancy because of a general immunity. All my pet monkeys and birds refused them, even when sandwiched in between edible species which were seized and eaten ravenously.

Jungle grasshoppers are found singly, many with leaf markings, or a broad ruptive streak down the back, and often with hidden flash colors, such as scarlet inner thighs, or abdominal tints, visible only in flight.

Family TETTIGONIIDAE

Long-horned grasshoppers are almost all extremely protectively colored, and as they are nocturnal, discovery of them in the daytime is usually accidental. They frequently come to light. Under the leaves of bushes and trees the narrow and broad-winged katydids rest, climbing to the upper surface and becoming active just before dusk. The extreme to which hypertely is carried is astounding—green leaves gnawed and jagged around the edges, leaves decayed to red and yellow hues; leaves with a center of skeletonized network; most of these belong to the tribe Meconemides.

A second tribe Mecopodies, is represented by fewer numbers, but very striking species; great three-inch, winged forms, lichened in hue and texture, living on tree-trunks and old logs, and brown-leaved long-horns clinging to bare branches like the last dangling sear leaf.

Family GRYLLIDAE

This family ranks fourth in numbers and conspicuousness, but in audibility it stands first. Of the seven known tribes, all occur at Kartabo, five are common, two rare, although Myrmecophilides would undoubtedly be recorded more frequently if the nests of ants were searched systematically. I once found representatives of all seven tribes of Gryllidae in a single day. Crickets are found from the very margin of the river to the highest dryest jungle, but seldom

at a greater elevation than a few feet from the ground, while the majority are wholly terrestrial. The season makes some difference in their numbers, and more in regard to their singing—the season of mating being dominantly the early part of the two rainy seasons, about May and November. Three tribes come occasionally to light, but singly and only on rainy evenings.

Tribe TRIDACTYLIDES

Common and sometimes abundant along jungle trails is *Rhipipteryx*, a black and white member of this interesting and little-known tribe. They are not wary, but are very conspicuous, and when frightened escape by tremendous leaps, followed by a long scaling flight. They feed upon the juices of decayed wood, and perhaps of leaves as well, and are sometimes found in scores in and on a single dead log.

The hind legs have been so modified for leaping that they have quite lost their walking function, and these insects are wholly quadrupedal. I have twice detected robber flies, Asilids, in the act of devouring these Orthoptera.

A very minute, closely related, similarly modified insect is found on the sand of the beach in company with springtails, and newly-hatched mole-crickets.

Tribe GRYLLOTALPIDES

There are two general types of mole-crickets at Kartabo. A large, very pale species confined to the sandy beaches and a smaller black kind, which occasionally comes about the waste baskets. Both are attracted by light, the beach one more frequently.

The littoral species is always to be found after dark, running over the sand. At the very edge of the water at low tides many young ones often run about, and individuals of all sizes are occasionally seen swimming. They are very fierce and cannibalistic, and if several are confined together, one only will be found in the morning. In the daytime holes and long tunnels are visible. There is no doubt that these insects spend the time of high tide hidden in the sand, beneath the water. When placed in a thick layer of sand and covered with water, they are well and lively after eight hours' immersion.

Tribe GRYLLIDES

The true crickets are represented by a number of species, most of which have habits similar to those in the north. They are usually

terrestrial, and in the jungle very tiny black ones are found under the fallen leaves. Others live beneath bark. Some of large size and others with square, yellow-rimmed wing covers, are very fleet of foot, and flat enough to creep into the smallest crevice. Tiny pale brown crickets come to the lamps in the evening, and numerous small, nocturnal voices are doubtless traceable to insects of this group.

Tribe OECANTHIDES

Although arboreal crickets are found in the highest jungle trees, true crickets are rare and I have seen but two individuals of a small green form, closely resembling a similiarly colored species of Trigonid.

Tribe TRIGONIDIIDES

The beautiful little Harlequin crickets prefer the more open trails and clearings to the darker jungle, and are found on bushes and low-growing vines, seldom quiet but running rapidly about, with palpi rapidly vibrating.

There are a number of species, almost all of bright coloring, although one is dull brown and another pale green. The nymphs of one Harlequin afford the most perfect mimicry of ants I have ever seen. The resemblance is exact to every superficial detail, the tell-tale thick hind femora being of a pale translucent green, which is invisible against almost anything, and yet ready at an instant's warning to carry the wingless insect at least a hundred times its own length. They associate with certain ants with impunity, and I have seen them crawling over membracids in company with a crowd of ants. In the ant¹ mimics, the antennae are short, but in others which are very like small wasps, the antennae, while long, are amputated by a terminal white portion, reducing the optical length to the correct hymenopteron extent.

Tribe ENEOPTERIDES

A large jungle leaf-cricket is the most abundant of its family at Kartabo. It lives on leaves in the jungle, or among bushes of the clearings. It is leaf-brown above and black on the sides, the color division cutting abruptly through face, antennae, eyes, body and wings. It is a persistent singer, and easily located from 5:00 P.M. until dark, on a leaf of some low bush, with wings elevated at right angles to the body, and hind legs drawn up to the same angle.

The song is a true trill, less than half a note apart, the wings vibrating slightly, but not enough to blur them. The tone comes in successive waves and is about an octave below middle C, although the quality makes it difficult to key it.

Order III—ISOPTERA

From the point of view of an intruding human being, termites or "white ants" rank second in a list of dominant organisms at Kartabo. These insects are without doubt the chief agency in the disintegration of dead wood in the tropics, with the consequent rapid return of the decaying plant material to the soil, thus making possible its utilization for the growth of other plants that spring up in place of the trees that have fallen. The burrows of termites also open the way for the invasion of molds, fungi, bacteria and water, which further the process of decay. It is Prof. Emerson's conviction that much of the luxuriant and rapid growth of plants in the tropical forest is owing directly to the activities of these insects. The habit of using sand and dirt in the construction of nests together with the burrows that many species of termites make in the soil, results in the mixing and aeration of the soil.

In addition to these two influences which termites exert with the consequent enormous effect on the plant life of the region, these insects are so abundant in numbers that they form the chief food supply for a number of animals, particularly three species of ant-eaters, *Myrmecophaga*, *Tamandua* and *Cyclopes*, two species of burrowing snakes of the genus *Leptotyphlops*, and several species of woodhewers, woodpeckers and antbirds, such as *Glyphorhynchus*, *Chloronerpes* and *Formicarius*. Certain social wasps of the genus *Polybia* collect the winged forms as well as soldiers and workers, and several Ponerine ants (especially *Neoponera commutata* Roger) raid the open termite trails and enter their nests. During swarms almost every insectivorous creature from centipedes and spiders to hawks and bats feed largely upon these insects, and such unsuspected animals as terns and monkeys.

The nests of the termites, both terrestrial and arboreal, on account of their constant temperature, permanency, food supply of termites or debris, and because of the social instincts of the termites, offer a haven to numbers of specially adapted animals, mostly insects, which are fed and often even reared by the termites themselves. Over fifty species of arthropods have been found in termite

nesting near Kartabo, forming with the termites, remarkable biocoenoses, with fascinating and remarkable interrelationships between the animals composing them. Birds such as trogons and parakeets, and the large tegu lizards make their nesting burrows in the very heart of termite nests.

The intensive study of Kartabo termites from the quarter square mile of jungle, carried on by Prof. Emerson, demonstrates the great value of such restricted research. Until his studies began, there were sixteen species of termites known from the whole of British Guiana. He has now recorded from the tiny restricted fraction of the Colony under investigation, eighty-five species, which means that the completed census will most certainly tally over one hundred forms.

Order IV—EUPLEXOPTERA

Earwigs are much rarer than in the jungles of the Eastern tropics, where in Borneo and the Malay States I have found them in great abundance. At Kartabo they occur in varied environments, under stones near the water, under bark of dead trees and among leaves. An interesting blind form was dug up four feet beneath the surface of undisturbed soil.

Order V—MALLOPHAGA

Mallophaga or bird lice are found epizootic upon almost all the birds of this region, and a considerable number of mammals. Although I have collected them from many hundreds of freshly-killed vertebrates I have never found them occurring to excess.

Order VI—CORRODENTIA

These curious little insects have been observed several times in the jungle, twice under bark on hard, undecayed dead wood. In the laboratory Psocids or book lice are found in numbers running about the inner bindings of any book which is not in frequent use.

Order VII—ZORAPTERA

This exceedingly rare order of insects is represented thus far by a single wingless specimen captured in a termite nest.

Order VIII—PLECOPTERA

The little known stone flies are rare, and only a very few larvae and adults have been observed, the former in the sand of Cuyuni creeks.

Order IX—EPHEMERIDA

Mayflies are common and at certain seasons abundant, immense swarms emerging at one time, and dancing in mid-air. The one most frequently seen is a large form with a line of silvery white down the back of the abdomen. I have watched a vast swarm of these insects twenty feet up, dancing for hours. Facing upwind, they hold the wings steady, slowly sinking for a few seconds, when with a single downward sweep of the wings, they regain their former altitude, and again float like tiny airplanes for a time. Occasionally the surface of the rivers is covered with their wings and bodies.

Among many others, a species of *Campsurus* with its degenerate meso- and meta-thoracic legs is common about the laboratory lights in the rainy seasons.

Order X—ODONATA

A great many species of dragon- and damsel-flies have been taken in the quarter mile research area, but no attempt has as yet been made to identify them beyond families. Of the first mentioned group, all four families are present.

To the Gomphidae belong good-sized insects which keep to the vicinity of water. Although not as swift fliers as some others, they are not often seen or captured, for they usually fly among thick undergrowth.

The largest dragon-flies belong to the Aeshnidae. They are haunters of the jungle and come to any pit or tub of water however small. When I sink a tub for aquatic Coleoptera a single large *Epiaeschna* or *Nasiaeschna* appears at once and takes possession. It drives away any related intruders, and flies back and forth over the diminutive pond, occasionally laying an egg in a crevice of the soil near by. When at rest it hangs suspended from a leaf, with the wings, which spread four or five inches, opened and flat. They are far from wary insects and will alight on one's hat or clothing. Members of this family are often seen hawking about in the air in close association with martins and swifts, feeding on swarming termites or ants, and they join the bats in crepuscular hunting as well.

Smaller dragonflies belong to the Cordulidae, and have the wings usually quite clear, and the abdomen often of a deep purple or red color.

Numerous species, some very common, are included in Libel-

lulidae, often with banded or spotted wings or dashes of color. They are the typical dragonflies of the jungle trails and of dry clearings far away from water.

Two families of the damsel-flies *Zygoptera*, vary in size from the most delicate, azure-bodied beings, fluttering tremulously on the tiniest of gauzy wings over creeks, swamps and the shores of the river, to the marvellous, giant *Mecistogaster* of the high jungle. These have wings which expand five and six inches and slender abdomens which trail out behind to an equal length. Their wings may be clear, or tipped with spots of yellow or white, and in shadowed aisles of the jungle these terminal spots, weaving about in confused motion, are often the only part of the insect visible to the eye of the onlooker. They breed in the water of the bromeliad leaves, high up on the trunks and branches of trees.

The smaller damsel-flies have brilliantly colored bodies and sometimes spots of scarlet on the wings. *Agrionidae* is the more abundantly represented family.

Nymphs of *Odonata* are abundant in all conceivable aquatic places, in the waters of creeks, both slow and rapid flowing, along shore and even in the deep water of the river, in isolated pits and the water of air-plants.

Order XI—HEMIPTERA

CRYPTOCERATA

The distribution of these is of course restricted to water, which, apart from the rivers, consists of temporary rain pools, mica pits, small creeks, and, in the vicinity of the laboratory, flooded pit traps. Certain *Hebridae* and *Notonectidae* frequent these places. The bromelias found on the mangroves harbour at least two species of *Hebridae*.

Group GYMNOCERATA

Judged from this standpoint the immediate neighborhood of Kartabo seems to support two distinct groups of bugs. The first, and larger, both in number of species and individuals, belongs to the clearings, and as might be expected, this hemipterous fauna does not appear to differ very greatly from that of the cleared plantation lands near the coast. Indeed, it is probably immigrant, and likely to extend in range as the cleared land increases in extent. The second, and apparently smaller, is probably the older fauna, native

to the primeval jungle, in which the clearings are made. It should be understood that the terms aboriginal and immigrant are used merely for convenience in this connection. The neighborhood of Kartabo has been occupied by Dutch and British settlers for the last three hundred years at least, and the addition of forms from more open country to the original forest fauna must have taken place throughout this time. Except perhaps as regards the carnivorous bugs, this jungle fauna is more restricted both in species and individuals than that of the clearings. In both cases, the relative abundance of different species in proportion to the number of individuals obtained is very marked. The occurrence of the different species is probably influenced considerably by rainfall and other climatic factors, as Hemiptera of all families are relatively more abundant in September than during the rains of June and July. Three large families of Heteroptera predominate in the area, Reduviidae, Coreidae, and Pentatomidae, in numbers both of species and of individuals. The first family is abundant in jungle and clearings. These three families include species of every size, and in the Reduvids of considerable diversity of form.

The Pyrrhocoridae and Anthocoridae include none but small forms, mostly confined to the clearings, and the same may be said of the Phymatidae.

Family PENTATOMIDAE

This is a large and dominant group. Some of its numbers are conspicuous in size and coloration, others are small, sober-hued forms. On the whole, the Pentatomids frequent clearings and sunny trails, although certain forms of considerable interest are confined to the deep jungle.

Family COREIDAE

Perhaps the most remarkable group of Heteroptera in size, number of species and diversity of form are the Coreidae. Coreid bugs are found in the clearings and in deep bush. Some exhibit curious and almost grotesque developments of the antennae and limbs; others are brilliantly colored, perhaps to repel enemy attacks, or else are inconspicuous to avoid being observed. The nymphal stages are frequently very different from those of the adult; and some species appear to live on decaying organic matter rather than on plant juices.

Family LYGIDAE

In comparison with the above the Lygidae are not only less abundant in species, but the individuals are less conspicuous in size and coloring.

Families ANTHOCORIDAE, CAPRIDAE, PYRRHOCORIDAE

These are represented at Kartabo by a number of small forms, generally obtained in the clearings by sweeping, and readily overlooked.

Family PHYMATIDAE

Represented by a few species frequenting open places. The same forms are much more abundant in the grasslands near the coast, and may even have appeared up the river comparatively recently in the wake of negro settlers and consequent clearing of jungle.

Family ARADIDAE

A few interesting bark-dwelling forms, protectively colored, are found on tree trunks in the jungle.

Family REDUVIDAE

Ranks with the Coreidae as one of the dominant families. There is great diversity of form, size and habitat. Certain species show remarkable resemblance to insects of other groups inhabiting the same area. Thus one "mimics" a sawfly, another an ichneumonid, two others resemble two different pompilid wasps, another apes an inconspicuous grasshopper, and so forth.

Order XII—HOMOPTERA

Family FULGORIDAE

The most striking of these insects are the huge lantern- or peanut-headed insects which are seen very rarely on tree-trunks. Smaller fulgorids of the most bizarre shapes and colors are more common. A very typical jungle form is a large insect with black wings covered with turquoise dots, and a remarkable tuft of long, curving, waxen filaments at the end of the abdomen. They are sometimes common, clinging to the trunks of trees, and present a very curious sight when flying.

Family CICADELLIDAE

These are perhaps the most abundant of the volant Homoptera

in the Kartabo fauna. They are mostly small, with very brilliant colors and striking pattern and seem to court observation by alighting conspicuously on the upper surfaces of leaves.

Family MEMBRACIDAE

Abundant, especially in half-over-grown clearings, where eggs, immature and adults spend their lives on a single stem, attended by their guardian and shepherd ants. The forms are beyond description in weird outlines, hooks, humps, knobs, blades, handles, pillars, curved projections forming absurd initials (in one case E L). All this elaborate protection is inexplicable, as no creature seems to feed on them, and most of the adults have the advantage of eyesight, leaping powers and wings. Seventy-four species have been recorded, in an unpublished monograph by Maud D. Haviland, of which twenty-six have proved to be new to science. Almost all are tended by ants of various species.

Family CERCOPIDAE

Frog-hoppers are common, a few abundant, many dull-colored, others brilliant, but not as a rule of unusual shape. By far the dominant form is *Tomaspis ruber*, black with two conspicuous yellow cross-bands, which always alights and remains in full view.

Family CICADIDAE

While not abundant as collecting goes, cicadas are aurally the most dominant form of insect life, their voices rising above all other sounds during the dry season. They range from very large to small forms, some with curious ocelli, others very like our northern cicadas. A common form with brown wings is frequently attracted to our lights in the evening, while others come more rarely. The "six-o'clock bee" of the colonist is a cicada, and is so-called because of its regularity of utterance each evening. Some of the jungle cicadas call from high up in the trees with vibrations of tremendous power, either single notes, or two, separate at first and merging into a true trill. Only once have I found cicadas gathered in any numbers, in May, when I observed thirty-six on the stems of a low Dalli sapling.

Five birds and a lizard are known to feed upon cicadas in the research district.

Family PSYLLIDAE

Two mutilated specimens have been taken from the mouth of a tiny frog. A few living species collected, one being an interesting gall-forming type, causing malformations which harbor a number of parasites and inquilines whose bionomics are very complicated.

Family APHIDIDAE

This family is mentioned to emphasize its almost complete absence, its place being taken by membracids. Only two true aphids have yet been found at Kartabo. They are not rare on the sea-coast.

Family ALEURODIDAE

The commonest member of this small group is an active larva which crawls over the leaves completely concealed by an astonishing growth of long flaxen filaments which project in every direction. Other nymphs are tended by ants. Winged adults are seen more rarely flying about among the leaves and low bushes of the jungle.

Family COCCIDAE

Coccids are legion, both unattached and in intimate association with ants and other insects. Sometimes a tree-trunk will be almost completely covered with small earthen mounds, each of which is a stable built for a coccid by some species of ant. Large brilliantly colored ones are found in the nest of *Azteca*, but for the most part they are dull of hue, or covered with a whitish exudation of wax.

Order XIII—PARASITICA

If one watches the daily ministrations of the Indians and native Boviander mothers to their children, the presence of representatives of the family Pediculidae cannot be doubted. No true lice have been found on any of the jungle mammals.

Order XIV—THYSANOPTERA

Thrips are found in every likely and unlikely place, most abundantly in flowers and under bark. On recently fallen trees scarlet immature thrips will suddenly appear in uncountable numbers under the bark, creeping out in the blazing sun of midday to go through most remarkable dances. They disappear as quickly as they come. The adults are far less numerous and fly with great difficulty, sometimes collapsing after a few inches of aerial progress.

Order XV—NEUROPTERA

Family HEMEROBIIDÆ

Only the larvae of these insects have been observed, and rather rarely, walking about on leaves in the jungle, each presenting a most curious appearance in being completely covered with bits of debris, its own old skins and the skins of the insects it has eaten, all fastened together with silk.

Family CHRYSOPIDÆ

The presence of the delicate lace-winged flies is more often indicated by their curious stalked eggs than by the larvae or imagos themselves. Often along the edge of a leaf, and sometimes on articles in the laboratory, lines of the long-stemmed, knobbed affairs are seen, each egg supported on a long, slender hair. The debris-covered larvae, encased usually in the down or hairs of plants, are found on leaves and stems in the jungle, which after a short pupal phase, also in a mound of detritus, emerge as the beautiful golden-eyed adults. These come occasionally to light, and I have reared them in stender dishes.

Family MYRMELEONIDÆ

I have seen no ant-lions in the jungle, either the pits of the larvae or the adults. The dry sand under the laboratory is pitted with their traps, and the adults are taken now and then. Others are found in the clearing near the jungle, and in old Indian cassava fields. An inch or two below the surface of the sand are found the globular sandy cocoons, the enclosing grains held tightly together with silk, and, if the adult has emerged, holding the perfect cast pupal skin.

Family ASCALAPHIDÆ

The adults, looking like ant-lions but with long, butter-fly-like antennae, come occasionally to light, and the larvae are found on leaves, looking strangely out of place. In shape they are like ant-lion larvae, but instead of being humped, they are unbelievably flat, and when resting on a bit of brown leaf are quite invisible.

Family MANTISPIDÆ

Decidedly rare in the research area. A large insect, apparently a wasp, flew from a tree-trunk directly on to my sleeve, one day. I brushed it off, and when it flew again and again at me, I retired

hastily, for a sting from a large tropical wasp often means a few days of fever. It flew after me and alighted on my gun, when I recognized it as a remarkable mantis mimicking a wasp. Not until I later pinned the insect did I realize that I had twice been fooled, and that it was in reality a member of this family, and quite unrelated to the Orthopteran mantids. I once found the remains of a mantispid in the stomach of a woodhewer, *Dendrocincla*. The larvae and pupae of mantispids have been found in cells made by spider-storing wasps in the nest of one of the *Armitermes* termites.

Order XVI—MECOPTERA

All I know of scorpion flies, *Panorpidae*, is that now and then the adults come to my light at night in the laboratory.

Order XVII—TRICHOPTERA

Caddis flies play but a small part in the fauna of Kartabo. Imagos come now and then to our lamps in the evening, but the larvae and their cases are common in the river and locally abundant in the jungle streams. Under stones in front of the laboratory are small scarlet forms living in soft linear cases made of muddy debris; also the more attractive *Helicopsyche* occurs, tiny mosaics of sand grains resembling coiled mollusk shells. In creeks farther up-river are large caddis-worms inhabiting houses of large pebbles, held together with a silken web. The larvae themselves are most remarkable, with elongated gills on the protected areas of the body, the anterior segments being hard, and the whole of most brilliant, varied colors, some individuals dominantly turquoise blue, others green.

Order XVIII—LEPIDOPTERA

The moths and butterflies form one of the most conspicuous groups of insects to be found within the quarter square mile of research area at Kartabo. The range of color and size among them is great, the size varies from minute micro-lepidopterons smaller than mosquitoes, to great moon moths, twelve to fourteen inches across the wings; the colors range from dull grays and browns through the chromatic scale to the brilliant, metallic-blue, refraction iridescence of the morpho butterflies.

The number of species observed and taken at Kartabo is very considerable, about 1215 in all, of which about 401 are butterflies and approximately 814 moths. It is probable that half as many again remain to be recorded.

Suborder HETEROCERA

For some wholly unknown reason sugaring and jacking are almost failures as regards moths at Kartabo. One hundred miles away in the Northwest District of Guiana I have had remarkable success with both methods, but at Kartabo none of the dozens of attempts has produced any but negative results. Hence the collection has had to consist of the casual individuals which flew into the bungalow on rainy nights, or whatever species were alarmed and caught in flight in the daytime, or what could be reared from larvae. Jungle moths are at the height of their abundance about mid-September. The 800 forms recorded probably represent only a very small fraction of those actually present.

The following twenty-three families of moths have been taken in the research area at Kartabo:

Sphingidae	Notodontidae
Saturniidae	Liparidae
Ceratocampidae	Melalophidae
Castniidae	Cicinnidae
Hypsiidae	Eupterotidae
Amatidae	Lasiocampidae
Arctiidae	Cossidae
Noctuidae	Dalceridae
Periopidae	Limacodidae
Geometridae	Megalopygidae
Uraniidae	Pyrolidae
Epiplemidae	Micropterygidae,

besides a host of Microlepidoptera.

These comprise in all 814 species of moths, rather unevenly distributed, as the three families of Noctuidae, Geometridae and Pyralidae include 55 per cent. of the whole number. Among the more interesting are the following:

Family SPHINGIDAE

Although fairly strong in number of species, the family of sphinx moths is not especially abundant in individuals, and these are seldom seen unless searched for in the vicinity of sweet-scented nocturnal blossoms. One form of day-flying hummingbird moth is common, and always to be found at four in the afternoon in the clearings, about the Mazaruni primroses, *Sipanea*.

Family SATURNIIDAE

Fairly well represented, mostly with conspicuous ocelli on the hind wings, and usually clad in shades of brown and dull yellows. *Therinia* is a beautiful and abundant form, resting flatly and conspicuously on jungle leaves, and closely resembling a white fungus patch or the excrement of a bird.

Family CERATOCAMPIDAE

Three species only have been collected, two of which are large and very beautiful.

Family CASTNIIDAE

Three species; one very large. The commonest often escapes observation when at rest by a very close resemblance to an orchid. On the coast this family is one of the worst sugar-cane pests.

Family HYPSIDAE

. Small, rare and very beautiful moths, superficially resembling several forms of *Rhopalocera*.

Family AMATIDAE

Sixty-odd species of these exquisite little creatures. The dominant character of the Amatids is the resemblance of many to wasps. Both in transparency of wings, constricted abdomen, coloration and especially in the habit of curving the abdomen quickly around, these so closely mimic stinging hymenoptera that we have been deceived again and again. *Correbia* is almost exactly like *Calopter* among the *Lycidae* coleoptera.

Family ARCTIIDAE

Fifty species, mostly small, but of the most exquisite colors and patterns.

Family NOCTUIDAE

Over 150 species of bewildering variety from the tiniest of little brown "millers" to the giant *Erebus* moon-moths twelve to fourteen inches across the wings. Chiefly leaf-brown and grey in color.

Family GEOMETRIDAE

Eighty species defying any résumé, so widely diverse are their extremes in color, pattern, and size. All are delicate, and many show soft shades of green. Perhaps the most common moth at Kartabo

is the exquisite *Chrysocestis*—whose wings are tiny sheets of mother-of-pearl, bordered with sealing-wax drops of gold.

Family URANIIDAE

With only two species, this family is more in evidence to the casual observer at Kartabo than a half dozen other groups with scores of forms. *Urania*, the big, green, day-flying moth, is common in migration and flying over the water every week in the year, and few days pass without a dozen or more being seen.

Family PYRALIDAE

Over one hundred small, inconspicuous moths of this vast group have been collected and named, and probably three or four times this number await more careful search.

Suborder RHOPALOCERA

Four hundred and one species of butterflies, representative of the following twelve families have been found at Kartabo:

Papilionidae	Heliconiidae
Pieridae	Nymphalidae
Danaidae	Riodinidae
Satyridae	Erycinidae
Brassolidae	Lycaenidae
Morphidae	Hesperiidae

Family PAPILIONIDAE

Aristolochiad papilios, “poison-eaters,” velvety black with spots and bars of brilliant red and green, are the commonest forms of this family to be found at Kartabo. They are essentially insects of the jungle, ranging from near the ground upward, but seldom reaching the tree-tops. Occasionally individuals may be found within the clearings, drawn out of their shaded homes into the sunlight by the greater quantity of flowering plants to be found in the open spaces. These butterflies are slow-flying, the wings moving continuously, never sailing with set wings, they are fearless of man, and usually alight in the most conspicuous spots on the tops of leaves. The caterpillars are mottled greens, grays and browns, sometimes marked with white or yellow. A few species as they sit in their usual diurnal position in the center of a leaf, resemble the excrement of birds.

Representing another group of papilios is the southern form of

our northern swallow-tail, or "orange dog," although it is by no means common. It is a swift and powerful flier, always found in clearings, and never within the jungle.

The family, as a whole, ranks among the common insects to be found within the research area.

Family PIERIDAE

This family is rather well represented, especially in forms frequenting the clearings. At certain times of the year, large migrations of male butterflies of the genus *Catopsilia* occur at Kartabo and many other places in British Guiana. These migrations are practically always to the northwest of Kartabo, and sometimes continue for days, the number of insects taking part mounting into hundreds of thousands. Occasionally, for a short time, the direction of the migration may be reversed.

These butterflies are capable of long sustained flights, usually flying when on migrations from two to six feet from the ground, following closely the contour of the country, over rivers, through clearings and, when the jungle is reached, flying straight across the top, and continuing onward over the roof of the forest.

The larger pierids,—yellows, oranges and whites, in appearance and habits much like our northern cabbage butterflies,—inhabit the open clearings. One or two species of this group have adopted the colors of some of the jungle butterflies and have left their clearing homes for the shaded jungle. Instead of possessing broad wings and the usual self colors of the pierids, these butterflies (*Dismorphia*) have long narrow wings, white, bordered and barred with dark greenish brown above, and with a broken brilliant orange band on the lower surfaces of the hind wings. In these forest forms, the flight has also changed, and has become slower, simulating the flight of the species they most closely resemble, especially the danaid *Aeria*.

Family DANAIDAE

The southern form of the monarch is occasionally found in the research area at Kartabo, but it is by no means common. It inhabits clearings, and caterpillars have been found feeding upon *Costus spicatus*.

Ithomiids are the butterflies most typical of the forest about the research station. The greater number of forms are bright yellow and brown, with black bars and patterns; some have opaque wings and others are quite transparent. Their flight is slow, the wings

moving continually, gently and softly. These are found in low and mid-jungle, seldom ascending to the tree-tops or upper portions of the jungle. Small glades and trails within the forest are their favorite spots, where they flit slowly about, their brilliant colors flashing forth as the sunlight falls upon them. Many of these butterflies have social sleeping habits, numerous individuals assembling each evening on one or two bushes, and spending the night close together. Other species have peculiar dancing habits.

These, as we have demonstrated again and again, are distasteful to monkeys, lizards and most birds, and as they are more numerous in individuals, they have served as models for many more edible, but less abundant, butterflies. So close is the resemblance, down to most minute details, that in many cases it requires careful examination with a hand lens to distinguish between them.

Family SATYRIDAE

Satyrs and wood-nymphs are common, many species being found, living entirely within low jungle and near the jungle floor. All are dull browns and grays and blues, while in a few species the wings are wholly transparent. Almost all are characterized by the possession of bright-colored ocelli on the hind wings. The transparent species never alight anywhere but near the ground, immediately vanishing from sight.

Family BRASSOLIDAE

Equally as common as the Morphos are the insects belonging to this family. The most abundant forms are owl butterflies (*Caligo*) with dull purplish upper surfaces of the wings, and mottled gray, white and brown under surfaces, ornamented with a large bluish ocellus on each hind wing. These butterflies are crepuscular and delight in flying up and down trails within the jungle, and along the edges of clearings. Caterpillars are often found, and are especially common on the long leaves of banana.

A number of other species are found within the research area, always in the jungle, and possessing sombre shades of brown and buff above, occasionally with brilliant patches or bands of bright blue, yellow or purple. The undersides of the wings are covered with intricate patterns of grays and whites and browns.

Family MORPHIDAE

The most brilliantly colored butterflies are the Morphos. Dur-

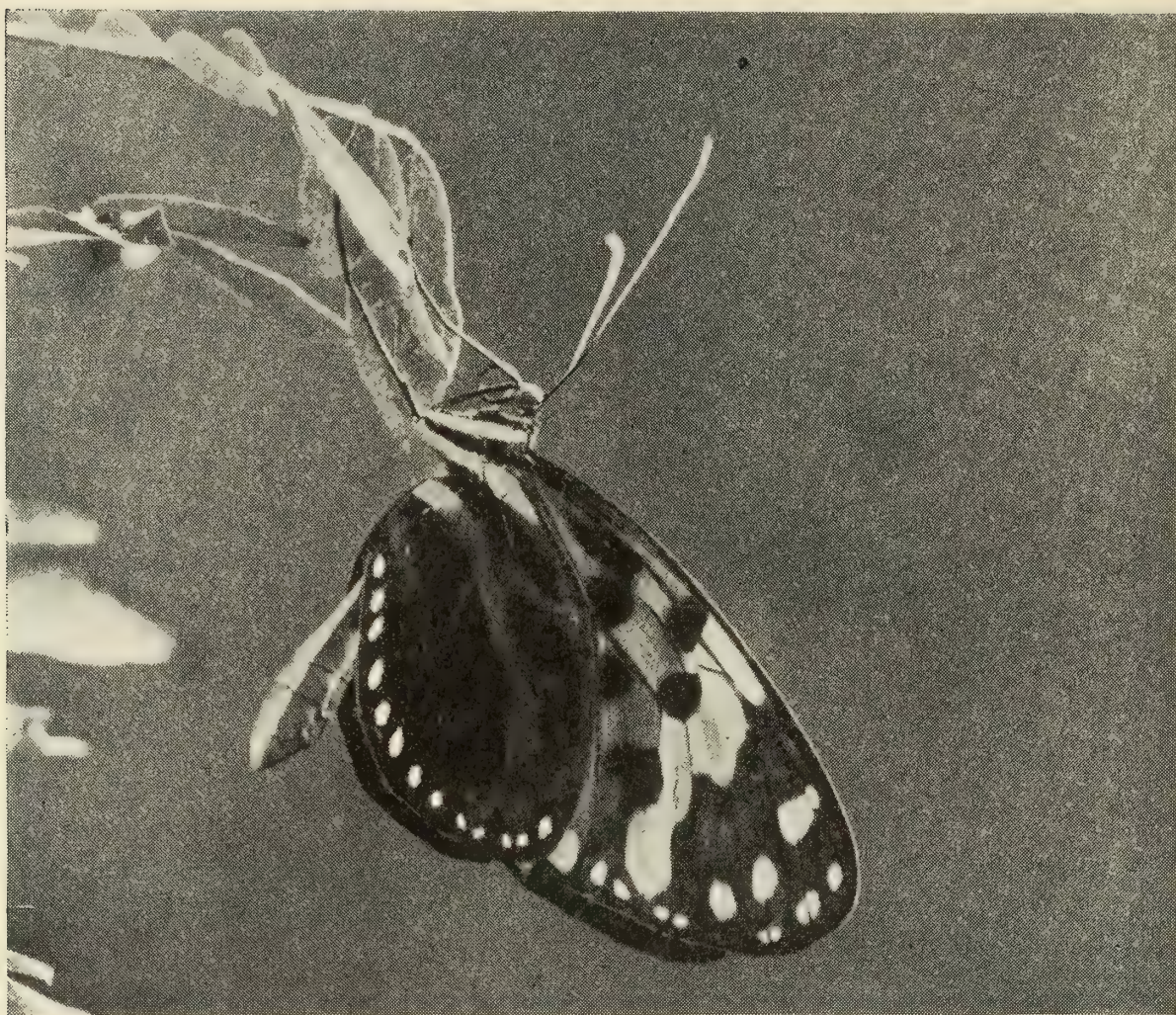


Fig. 10. A sleeping Danaid butterfly, *Melinaea mneme* Linn.
Photograph by William Beebe.

ing the beginning of the rainy seasons *Morpho menelaus* is especially abundant. These magnificent insects may be seen flying through the jungle, preferring trails and glades and especially open spaces above streams, and occasionally entering the clearings. During flight the wings move slowly, the insect progressing in undulating waves, the crest of each wave from six to fifteen feet beyond the preceding. This species is seldom seen above mid-jungle.

Occasionally, high in the air, over the tree-tops, may be seen the brown and yellow females of *Morpho hecuba*. Unlike the more brilliantly colored species these seldom descend to the ground or low jungle, but remain in and above the tree-tops.

Three broods of morpho caterpillars have been found. All were found in daylight, congregated on the upper surfaces of leaves suspended over the waters of the river. All the caterpillars were brilliant scarlet, with pale green saddles and cross-patterns, and extremely conspicuous.

Family HELICONIDAE

This essentially neotropical group is quite well represented at Kartabo. Like the ithomiids, which they closely resemble in form and often in pattern and color, they are insects of the jungle, seldom entering clearings, preferring trails and shaded glades. One species resembles the common yellow, brown and black ithomiid, forming with a similarly colored but rare danaid, a mimicry ring. The forms most common within the research area are black, with red cross-bars on the wings, or irregularly marked and spotted with yellow, blue and red. A very small, yellow-brown heliconid, belonging to the genus *Eueides*, is very often found along the edge of the clearing, resembling a common nymphalid, *Colaenis*, in form and color, but distinctly smaller in size.

Family NYMPHALIDAE

Many of the tree-top forms belong to this group, and they are also found distributed through the jungle. Their colors and forms are varied and no generalizations can be made as to their appearance. Some of the commoner forms are among the most beautiful insects to be found at Kartabo, such as *Ageronia*, the Calico, with its indescribable mottling of grays, blues and browns, or *Nessaea*, brilliant green beneath, and orange, black and shining blue above.

Family RIODINIDAE

Seven species only have been found of this small family, the most abundant and striking being *Helicopsis*, a small moth, pale yellow and black, with gold bespangled hind wings drawn out into six pairs of tails.

Family ERYCINIDAE

This group is represented by many species, but a comparatively small number of individuals. Mimicry of other forms is evident, and some of the resemblances, especially among those mimicking satyrids, are quite remarkable. These butterflies are small to medium in size, found entirely within the jungle, especially near trails and in low jungle. In coloration they vary from yellow and dull grays and greens to brilliant orange, barred and mottled with black and white, but on the whole are of bewildering variety of form and color. In alighting the erycinids have one habit in common,—they always rest on the under surfaces of leaves.

Family LYCAENIDAE

This family is only moderately represented by about thirty-five forms at Kartabo within the research area, and is only fairly common in individuals. The hair-streaks and blues that are to be found, are confined to the jungle and to the edge of the denser thickets, and are most easily captured as they fly near trails.

Family HESPERIDAE

The Skippers form one of the most abundant families to be found within the research area. They are especially common within the clearing and along the edge of the jungle. Their color is usually brown, with spots of white or buff, or bold splashes of yellow.

Within the clearing, the most common form is a small mottled gray and white species of *Hesperia*. It is always present and seldom flies more than three feet above the ground. This skipper, unlike most of the other representatives of its group, flies rather slowly, the wings moving continually as the butterfly threads its way among the twigs and branches of the smaller bushes near the ground. When alighting the wings are held half way between vertically and horizontally, and after one or two soft wavings, their position changes to vertical, and the upper surfaces face and touch each other.

A number of hesperid caterpillars have been found feeding upon the leaves of the giant bamboos about the station.

Order XIX—COLEOPTERA

About forty families of beetles have been recognized in the quarter square mile under observation.

No detailed classification has yet been attempted and the number of families will undoubtedly be greatly increased when this is done. The number of species of beetles far exceeds that of any other group of insects. A conservative estimate of the coleopterous fauna of the quarter square mile, based on a composite of the number suggested by several entomologists, is ten thousand, of which over half would be divided between the three families of Chrysomelidae, Staphylinidae and Rhyncophidae, the flower beetles, rove beetles and weevils.

The food content of many hundreds of birds' stomachs gives a similar indication of the great abundance of beetles, as more than one hundred and thirty species of birds have been found feeding on

them, Hymenoptera being second, having entered into the diet of ninety-five species.

Yet as far as individuals goes there is no comparison with ants, wasps, termites or flies, all of which infinitely outnumber the beetles. But in number of species the latter far excel the other families.

Family PASSALIDAE

These big, black, slow-moving beetles are the commonest inhabitants of dead logs. At least half a dozen species have been taken without any special search. They would well repay careful study, because of their interesting social and family life, the adults and larvae living together and communicating by audible squeaks.

Family SCARABAEIDAE

This is one of the most interesting and numerous families. Especially the Coprides, which come in numbers to carrion, in bewildering variety. They range from the tiniest of tumble-bugs to giant purple and glowing copper scarabs. Thirty-five species came within a few days to carrion which we exposed. The other tribes of this family, including the cockchafers, so-called June bugs and cetonids are all found in abundance. The latter especially can be collected in numbers about recently felled trees.

Family CICINDELIDAE

Tiger-beetles are not very abundant, apparently not being well adapted to life in the dark humid jungle. In the clearings, however, they are found, and scores of "doodle-bugs" make their tunnels in the compound of the laboratory.

Family CARABIDAE

Ground beetles are not nearly as abundant as in the north. The most abundant is a good-sized black species with large jaws, common in pits and eaten by Bufos. In the compound big yellow and black bombardier beetles are abundant at certain seasons, shooting out a spray over one's fingers which in odor and stain is exactly like iodine. On the sand of the beach tiny nocturnal carabids mimic young mole crickets in arenaceous coloring and in their palmate fossorial front tarsi. Under bark is a favorite place for many carabids.

Family HALIPLIDAE

Minute, rather slow-swimming beetles, quite common in pits and artificial water-holes.

Family DYTISCIDAE

Abundant both in species and individuals. A dozen species were taken in a small tub of water sunk in the jungle.

Family GYRINIDAE

Much more common in the river than in the jungle creeks or pools. When not gyrating some species spend the heat of the day in pairs on the shady side of stakes well above the water.

Family HYDROPHILIDAE

Found both in the river and in the jungle, but less common than the dytiscids.

Family PSELAPHIDAE

Three species of these small interesting beetles have been taken in the nests of termites.

Family STAPHYLINIDAE

Rove beetles form one of the three dominant families of coleoptera, at least in point of numbers of species and individuals. They are found under every condition where coleoptera live, especially on decaying animal matter, fungi and under fermenting bark. They show extreme adaptation to the various environments in color, size and shape, and offer an almost untouched field to the neotropical coleopterist.

Family HISTERIDAE

Although always with the rounded, shining black characters of the family, these beetles differ widely in habitat and the mere glimpses I have had of their larvae show that the diversity in appearance and habits is very great. Carrion, fungi and rotten fruit attract the greatest numbers.

Family SILVANIDAE

These come to lights and several times have been found under bark.

Family EROTYLIDAE

Fungi appears to be the almost exclusive haunt of these ornate beetles, where they are found in numbers, varying widely as to size but usually of a red color.

Family COCCINELLIDAE

Lady-birds, like some other tropical creatures, far transcend

our northern species in brilliance of pattern and coloring, but almost all are small.

Family DERMESTIDAE

Various species quite unlike our northern pests are found infesting our insect collections if not carefully watched.

Family BYRRHIDAE

A remarkable assemblage of small beetles whose antennae, head and legs fit so perfectly into grooves that they appear to be merely lines etched on a curved, perfectly smooth surface.

Family PTINIDAE

Small beetles occasionally coming to light; these have been found in dry bark.

Family LAMPYRIDAE

Fireflies are abundant in species and individuals at certain seasons, and glow worms are occasionally found. There is great variety in intensity and in color of the light. Still more numerous are beetles (*Telephorides*) similar to our soldier beetles of the north, and large black and yellow wide-elytraed *Lycides*. These latter are often very abundant about recently felled trees.

Family CLERIDAE

Small, brightly ornamented beetles, seldom seen.

Family ELATERIDAE

One of the dominant families in size and numbers. On a recently fallen tree many species can be taken as they zoom past, looking for a place suitable for their eggs. The giant lightning bugs which illumine the jungle are click beetles. In a new camping place a flash-light or lantern will often draw fifteen or twenty, which come streaking like meteors through the trees.

Family BUPRESTIDAE

The two first sentences under Elateridae apply with equal force to these insects. They are the wasps of the beetle world, nervous, quick, wary and of brilliant color and pattern. They fly swiftly to dead tree-trunks and run with equal facility over the bark. The largest of all the Kartabo beetles,—the “sun-bee” of the

natives and "chee-ree-gib-bee-puh" of the Akawai Indians is a monster iridescentally metallic buprestid, three inches long.

Family TENEBRIONIDAE

A very large and diversified family, living chiefly in dead wood and fungi. A large black species inhabits the roof of the laboratory.

Family CISTELIDAE

Fewer in numbers than the preceding, but resembling it in general appearance and habits.

Family MORDELLIDAE

Common at certain seasons, resting on the leaves of low bushes in clearings. Brilliant in coloring and equally efficient in leaping, running and flying.

Family RHIPIDORHINIDAE

Medium-sized beetles with narrow elytra, plumose antennae, and variegated patterns, on flowers and leaves.

Family CANTHORIDAE

No adults have been taken, but the larvae have been occasionally found attached to bees.

Family BRUCHIDAE

A great variety of beetles come under this family, some large and tenebrionid-like, others small, with marvellous patterns, resembling some of the active bark weevils.

Family CHRYSOMELIDAE

The number and variety of these flower beetles is unbelievable. Only a comparatively few species are taken in numbers, while many of the forms are uniques, seen only once during five years of collecting. The dominant characters are smallness of size, the marvellous colorings and patterns, and a universal habit of death-feigning when alarmed. The variety of situations in which they are found suggests a corresponding diversity of habits and conditions of development. Most of those living under bark are lichen- and wood-hued and of paper flatness, while those on leaves may be extremely convex and glowing like living gems. Most creatures refuse them as food, but cuckoos, toads and organisms with a corresponding catholicity of taste devour them greedily.

Family CERAMBYCIDAE

The tropics are famous for their wonderful longicorns, and Kartabo sustains this reputation. While well to the fore in numbers, this family probably excels in diversity of form and pattern. Some are tiny, with a negligible, almost thread-like body, larger ones have the elytra covered with hieroglyphics which appear almost decipherable; others have immense tufts of parti-colored hairs on the antennae or the hind legs, while the giant long-legged *Acrocercus* is in a class by itself.

In mimicry alone this family is supreme, and I occasionally take forms which in shape, size, color, pattern and, most astonishing of all in action, are perfect imitations of bees and wasps.

By far the commonest, and almost the only form which ever comes to light, is the green and yellow *Chlorida festiva*.

A coleopterist could spend a life-time at Kartabo, studying this family alone, and have but little time hanging heavily on his hands.

Family ANTHRIBIDAE

Fairly common, but difficult to define and no definite notes have been made upon their haunts or habits.

Family CURCULIONIDAE

One of the three dominant families, if not actually in first place itself in point of species. Weevils are not conspicuous to the casual walker through the jungle, but in week after week of collecting, the weevil boxes are the ones which soon fill to overflowing. Again we find rather an enormous number of species represented by one or a very few individuals, than any great preponderance of beetles themselves. Giant palm weevils and others equally large with inexplicable furry beaks covered with dense auburn hair are at one extreme, while the small wasp-like, active bark beetles represent a wholly different type. Mother-of-pearl weevils which close up and drop to earth at a touch are the most abundant on the leaves of the undergrowth.

Family BRENTHIDAE

These are usually bronzy beetles with enormously elongated thoraxes. The largest species are found under bark, never doing anything as far as my brief observations go. They are slow walkers and do little to avoid capture.

Order XX—STREPSIPTERA

Family STYLOPIDAE

Twice only have we observed a member of this parasitic group imbedded between the segments of the abdomen of a wasp.

Order XXI—DIPTERA

Very large collections of two-winged flies have been assembled, but only a beginning has been made in specific identification. They are present in enormous numbers, but under ordinary circumstances are not conspicuous. On a walk through the jungle, only here and there is a fly seen resting on a leaf or hovering motionless in mid-air. At the laboratory there is almost never a fly on the dining table, and at our work a few midges in early morning during the rainy season are all that interfere. One species of biting fly alone is ever troublesome, and this in extremely small numbers, easily killed, and in the rainy season only. At the most two or three may attempt to bite during a long walk.

But at a bit of decayed meat, or a sudden growth of fungi or oozing sap, hosts of flies will gather at once. Also, several sweeps of a fine-meshed net among the jungle undergrowth will often take hundreds which, in the dim light, were invisible to the eye.

Out of seventy-one families of Diptera in the world, forty-two, or about 60 percent have been already detected in the quarter of a square mile of jungle under observation, and future search should bring the total up at least to sixty families, as that number should reasonably occur, according to geographical distribution.

Family CECIDOMYIIDAE

These minute insects are taken in the sweep net both in clearings and the jungle and their galls are abundant, seen on weeds, bushes and the smaller twigs of trees.

Family MYCETOPHILIDAE

A few have been observed on fungus. Doubtless a careful search would reveal large numbers.

Family CULICIDAE

Many species of mosquitoes are found in the jungle, but only under abnormal and very unusual conditions are they ever troublesome. Ordinarily no nets are ever used in the sleeping tents and

one may sit quietly for hours in the midst of a swamp without hearing a mosquito or being bitten. The unprecedented drought of the spring of 1924 resulted in the formation of large numbers of isolated pools near the rapids of the Cuyuni in which vast numbers of mosquitoes developed before the beginning of the long delayed rains. These spread over the country, became infected by the Indians, and for the first time we all suffered from brief attacks of malaria. Most of the natives have chronic fever but make no attempt to combat it.

Giant, brilliantly colored mosquitoes breed in the bromeliad water, and go piping through the jungle, sounding like young birds calling for food.

Family SIMULIIDAE

"Black flies" are very rare at Kartabo and their place is taken by the following family.

Family CHIRONOMIDAE

The larvae of these midges form an important item in the food of the smaller shore fishes, and the imagos emerge at intervals in countless swarms. These aquatic species confine themselves, however, to the boats and stellings; they do not bite, and seldom fly more than a foot or two above the water or shore.

Tiny black midges are sometimes troublesome for an hour in early morning and late afternoon.

Family PSYCHODIDAE

The tiny moth flies are locally very common. A large species is abundant about out-houses, and a very small grey-haired form has been reared from fungus.

Family DIXIDAE

Inconspicuous flies, rather rare, long-legged and buffy in color, taken in sweep-net in jungle trails.

Family TIPULIDAE

Crane flies of all sizes are common, especially in the dark cavities of hollow stubs, under over-hanging banks and at lights in the evening.

Family BIBIONIDAE

Not rare, the commonest being a large smoky-winged species with red thorax hovering about fallen logs.

Family RHYPHIDAE

Small, mosquito-like flies of this family are occasionally taken in jungle trails.

Family STRATIOMYIDAE

An abundant group, some very large, and many with bizarre shapes and brilliant colors. They are found over water and on the damp bark of trees. Some have a transparent window at the base of the abdomen, giving the appearance of a slender, wasp-like pedicle. A yellow-faced species has a circular body, purple, touched with grey.

Family LEPTIDAE

Medium-sized flies, with marbled or otherwise variegated wings, common in the jungle, chiefly about decayed fruit or rotten wood.

Family TABANIDAE

Abundant in a great variety of places, including some very large species. The yellow, band-winged "deer-fly" is the only fly which ever bites one along the jungle trails. The beautiful pale-green *Tabanus mexicanus* is occasionally found in the laboratory at light, but is seldom seen outdoors.

Family THEREVIDAE ●

Medium-sized flies, closely resembling small robber flies and with similar habits.

Family BOMBYLIIDAE

Bee flies are not common, but very beautiful, heard and seen hovering in mid-air, often close to the jungle floor. They are so wary that it requires the most careful stalking to capture them.

Family ACROCERIDAE (CYSTIDAE)

The commonest species resembles a good-sized metallic bee, with enormous eyes and a proboscis so long that it extends back twice the length of the entire body.

Family MYDAIDAE

Very large flies resembling asilids, but with slow flight among the undergrowth.

Family ASILIDAE

One of the largest groups of flies and by far the most conspicuous. A dozen species can be seen on a single walk along a jungle trail. They rest on leaves waiting for their prey to come in sight, and return to the same position to devour it. Their diet includes almost all kinds of insects, with flies and bees, and especially trigonid bees, in the majority. Robber flies are of all sizes and colors, some being almost mosquito-like in their delicacy, others closely resembling in size and color and hairiness the largest *Xylocopa* bees, doubtless an authentic case of aggressive mimicry.

Family EMPIDAE

A hundred of these tiny flies may be taken at times in the jungle with a few sweeps of the net, but to the non-Dipterist they form but a slight visible proportion of the life of the jungle.

Family DOLICHOPODIDAE

These come second to the asilids in general visibility. A few steps along any jungle trail is sure to reveal one of these long-legged, iridescent-bodied flies running over the surface of a leaf, or waiting quietly for the small creatures which form its prey. I have never seen them in any other situation.

Family PHORIDAE

Abundant around dead animal matter and in mid-air in trails. Wingless phorids are common on fungi and as guests of army ants.

Family PIPUNCULIDAE

Tiny flies with enormous heads and eyes are captured in sweep-nets in the deep jungle.

Family CONOPIDAE

The commonest species are remarkably perfect mimics of wasps, and the advantage of this is very evident when we know that the females lay their eggs on the bodies of various hymenopters.

Family SYRPHIDAE

Flower flies are relatively less abundant than several other groups, but all are dazzlingly brilliant or decorated with bright yellow. They are chiefly to be found hovering in mid-air in clearings.

Acalyptrate MUSCIDAE

This hodge-podge of flies is represented by a vast number of widely varying forms, some iridescent, others with beautifully marbled wings, while some have legs of enormous length. Many species are found walking about on sap-covered bark laying their eggs in crevices. *Drosophilids*, as elsewhere, are abundant on over-ripe fruit, and hosts can be taken in a few sweeps of the net in the jungle.

The following are a few of the families which have been distinguished:

Sciomyzidae	Trypetidae
Geomyzidae	Sapromyzidae
Drosophilidae	Ortalidae
Psilidae	Agromyzidae
Tanypezidae	

Family ANTHOMYIIDAE

These are small editions of house flies which are abundant about decaying animal remains.

Family TACHINIDAE

A few of these big, hairy flies have been taken in the jungle, but the majority of the species and individuals have been hatched as parasites from caterpillars and chrysalids of lepidoptera.

Family DEXIIDAE

Several flies, closely resembling Tachinids, conform to the characters belonging to this family.

Family SARCOPHAGIDAE

Very abundant on all decaying animal matter but never coming into the laboratory or tents. This is inexplicable, as thousands may cover a dead animal or bird which has been put out a few yards away, to attract vultures, and yet no member of this family is ever found on our dining or work tables. Some appear exactly like northern house flies, others are large and marked with beautiful patterns.

From the body of a small antbird in a state of advanced decomposition, I took, within a period of fifteen minutes after exposure, twenty-two species and eleven hundred and forty individual flies, the majority of which belonged to this family.

Family OESTRIDAE

The larvae are frequently found under the skin of wild animals, and are sometimes so abundant on nestling birds that they cause death. Imagos, sometimes of very large size, are captured now and then. The largest measured over an inch and a half in length. I, and several members of the staff, have had "mosquito worms" deposited in the shoulder or behind the ear. Our love of science fell short of allowing them to develop!

Family HIPPOBOSCIDAE

These strange flies are not uncommon on certain wild mammals. I have taken forty deälated individuals from a small deer. A large collection of feather flies has been made from birds—the gallinaceous forms almost always having several swimming through and over the plumage.

Family STREBLIDAE

Winged flies of this remarkable family are taken occasionally on bats.

Family NYCTERIBIIDAE

These strangest of flies, wingless and highly specialized for their limited environment, are found only in the fur of bats, and each species of bat appears to have its particular form of nycteribid.

Order XXII—SIPHONOPTERA

Family PULICIDAE

Fleas have been found on a number of wild animals, while "jiggers" are abundant on the sandy floors and yards of Indian benabs.

Order XXIII—HYMENOPTERA

As far as any adequateness of treatment is concerned I might just as well say that ants, wasps and bees are present in vast numbers in the quarter square mile of jungle, and then turn to the next group of organisms.

I have made only the most casual attempts to divide them into families, and no group has as yet been studied completely by any competent Hymenopterist.

Although quite inadequate for any thorough, modern, taxo-

nomic treatment, Sharp's general arrangement of Hymenoptera in the *Cambridge Natural History* has proved satisfactory for my present purpose. So I have constantly adhered to it, merely raising a number of his subfamilies or tribes to the more modern view of families. Out of forty of his families, neotropical in range, I have found about thirty at Kartabo.

Family TENTHREDINIDAE

Saw-flies are not nearly as abundant as they are in the north, while the relatively great abundance of individuals of the species is more like northern organisms than is usual in the tropics. The commonest is a small species which crawls slowly about on the leaves of the jungle, while at times a yellow-bodied form is extremely numerous, flying slowly along close to the jungle floor. The function of this family is most certainly usurped in the research area by some other group.

Family CYNIPIDAE

These little insects and their galls are abundant but no notes have been made upon them.

Family PROCTOTRYPIDAE

Numbers of species of these very minute wasps have been bred from butterfly eggs. The only notes made have been on the number of individuals in each egg, and the sex. From eleven to twenty-five proctotrypids find nourishment and the wherewithal for growth and development in each lepidopterous egg, and in several dozen carefully observed instances there has never been more than a single male, who fertilizes all of the females as they emerge.

Family CHALCIDIDAE

Found everywhere in bewildering variety, a few of remarkably large size, most beautifully sculptured and patterned, and in color from buff, yellow, red and blue to the most intense iridescence. Over fifty percent of all the lepidopterous caterpillars taken are parasitized with these or closely related forms.

Families ICHNEUMONIDAE, BRACONIDAE

I have bracketed these two families because of the similarity in superficial appearance in the field and the identity of habits of the

more conspicuous forms. On a single long walk I have taken about fifty individuals, which would prove to be about evenly divided between the two families. They are found flying low through the underbrush searching leaf after leaf, both upper and under sides, for the prey which they parasitize. The majority of the larger forms of both families have yellow- and black-banded wings.

Family STEPHANIDAE

A small family of insects resembling the above.

Family EVANIIDAE

Not rare and most remarkable in shape, some appearing as if the abdomen had been amputated, this portion being reduced to a tiny knob protruding from the upper part of the thorax while others have enormously elongated abdomens which are parti-colored and held aloft.

Family PELECINIDAE

A half dozen specimens with greatly elongated abdomens have been taken of these insects.

Family CHRYSIDIDAE

Fairly common insects clad in magnificent reticulated armor of glittering blue-green.

Family MELIPONIDAE

This family is the most characteristic group of Tropical bees. It includes the *Melipona* and *Trigona*, mostly small black or brown insects about 6 mm. long. These are stingless, social bees, usually building mud or waxy nests in logs, in the ground, in odd corners of buildings or even in termite nests. One large colony had apparently experienced considerable difficulty in working over the nest carton and maintaining their entrances against the termites. Both entrances extended several inches beyond the normal circumference of the nest, giving evidence of a long struggle before the termites gave up and allowed the entrances to remain open.

The open mud nests were subject to enlargement by the addition of further hanging galleries until the colony reached its maximum size and swarming occurred. These nests were further characterized by the presence of bee-bread and honey pots, maintained in place by short, strong braces of wax and mud.

A considerable variation in pugnacity was found among the different colonies; the one described above would swarm out angrily and bite viciously if the nest were even jarred by a blow against the tree on which it was located. Other colonies could be examined at close range without apparently disturbing the inhabitants.

Some twenty odd species have already been described from Kartabo.

Family XYLOCOPIDAE

Seven species of these wood borers have been found at Kartabo and vicinity. They usually proved quite wary and were difficult to collect. The higher flowers were their favorite haunts, adding still more to their safety. One species reached a length of 35 mm., the females being black and the males mostly brown. In several other species, both sexes were black with hairy, ferruginous thorax.

Family CERATINIDAE

Few individuals of this family of carpenter bees were noted at Kartabo. Possibly three species. They are very small in comparison to the other family of borers, the Xylocopidae.

Family BOMBIDAE

In number of species, this family was poorly represented, only two having been described as yet. Even these species are open to question, it being possible that they are identical. The individuals are very numerous, however, and can be collected from any plant or shrub along trail or road, in cleared ground or on river banks. They are dull, slow of flight, and easily captured.

Family AUGOCHLORIDAE

About seven species of these little iridescent bees of the genus *Halictus* and the genus *Augochlora* have been noted. They are true tunnel makers, preferring the soft earth of the side of a pit or bank for their homes. Although they may use a common gallery into the earth, each bee has its own branch, this family being truly solitary.

Family ANTHOPHORIDAE

Seven species of *Centris* of the subfamily Centrinae are plentifully represented in the Kartabo region. Possibly the most numer-

ous species were large brown bees, invariably found around rivers. They seemed to enjoy basking in the sunshine on logs or planks; whirling in erratic flight about a passing boat or canoe; or investigating, with much interest, the paddler's hat or perhaps even his insect net. Their white-marked faces gave an odd impression of intelligence, well borne out by their elusiveness when pursued and their delight in taunting the pursuer by whirling past him with terrific speed.

Two species of *Melitoma*, also belonging to this family, were found.

Family MEGACHILIDAE

Four species of *Megachile* and at least one of *Coelioxys* have already been described. Those of the genus *Megachile* are the true leaf cutters and build nests or burrows lined with sections cut from leaves.

Family EUGLOSSIDAE

This family of long tongued bees is without doubt the most striking family found around Kartabo. Possibly fifteen species or more have been collected. Brilliant reds, greens and blues, combined with yellow and black, solid greens and solid blues and purples, present an assortment of color that cannot be rivaled. They possess an extremely rapid wing beat, enabling them to maintain themselves stationary in the air, while collecting their food from flowers. They are solitary, building in the ground or even in termite nests.

Including other unclassified specimens with the groups considered above, one is justified in believing that from one hundred to one hundred and twenty species of bees have already been collected from the Kartabo region. Those listed above are the most common families, others occurring rarely.

Family EUMENIDAE

The small potter wasps are not nearly as abundant as a northern hymenopterist would expect them to be. Several species build their nests in the laboratory.

Family VESPIDAE

This is the largest family of wasps and hornets, or marabuntas,

as the natives call them. Their nests, large and small, are seen along the trails and in the deep jungle, near the ground and in the tree-tops.

Family MUTILLIDAE

The wingless, velvet wasps are present in numbers and there is an abundance of species. The wingless females are more often seen than their mates, and are gay with spots of gold and scarlet.

Family SCOLIIDAE

A widely varying and numerous group, some big, yellow and hairy, others small and iridescent green. I have found two of the extremes of size parasitizing larvae of Scarabaeidae, so it is reasonable to suppose that many intermediate types have the same habits.

Family SAPYGIDAE

Only a few of these have been collected, closely resembling members of the preceding family.

Family POMPILIDAE (PSAMMOCHARIDAE)

Very numerous, many of large size with black or orange wings, others grey, with banded wings. Some are very tiny and stick their mud cells to the beams of the laboratory. They tirelessly hunt dead and living leaves, trunks and twigs for their spider prey.

Family SPHEGIDAE

These strong mud-daubers are abundant, and certain of their number are among the largest of Kartabo hymenoptera, one specimen reaching an extreme length of two and one-half inches, and with a sting which would surely send a human victim to bed with a week of fever.

Family LARRIDAE

Moderate to large wasps, most of which nest in the jungle floor, while others build beautiful nests of plant-down on the under sides of leaves. Their colors are greatly varied, and they are only fairly abundant.

Family TRYPOXILONIDAE

The most familiar families of wasps at the laboratory are little black fellows which we call vial wasps, from their habit of seizing

upon every empty horizontal vial they can find, to divide it into little cells and stock with spiders. The group is small and only occasionally is one taken in the jungle.

Family BEMBECIDAE

These wasps have the untropical character of being only fairly numerous as to species with exceedingly abundant individuals. Every area of sunny sand in a jungle trail or clearing is sure to have dozens buzzing about or digging frantically, throwing up little spurts of sand as they sink from view. Persons new to the jungle have to be assured that, although these big, yellow wasps love to buzz alarmingly close to one's face, they are never known to sting without strong provocation.

Family NYSSONIDAE

A small family with a few species, resembling the preceding in many characters.

Families PHILANTHIDAE, CRABRONIDAE

Two unimportant Kartabo families of small, yellow-banded wasps, more abundant during the dry than the rainy seasons. Their habits vary widely and I have found them nesting both in the ground and in hollow twigs.

Family FORMICIDAE

One's first walk through the jungle, as well as the last day of many years' residence, results in the same conclusion, that ants by far outnumber all other groups of insects. But not until Prof. William Morton Wheeler had spent several months collecting them, did I realize the great number of species represented in our quarter square mile. Even in the much more restricted area of the laboratory compound, he found every genus of fungus-making ant known in the world, and on a single tree only one hundred and fifty feet away from the laboratory, Prof. Wheeler collected ninety-six species of these insects.

The abundance and remarkable habits of the army ants *Eciton*, and leaf-cutting ants, *Atta*, have led me to write several essays about them.³ But scores of others are equally interesting and would repay

³Jungle Peace, Chapter IX; Edge of the Jungle, Chapters III, VII, VIII.

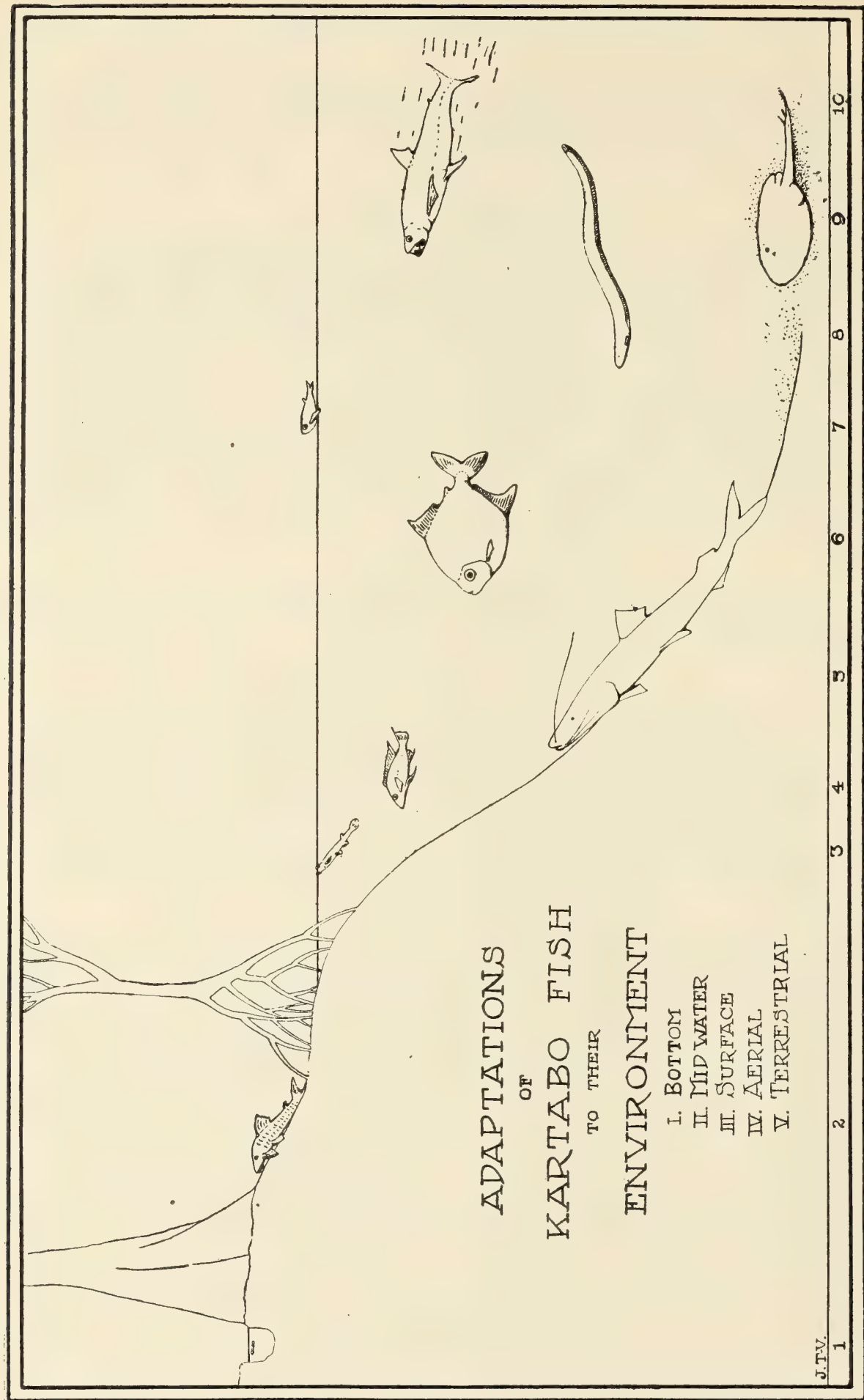


Fig. 11. Adaptions of Kartabo fish to their environment.
Drawing by John Tee-Van.

months of study. The most conspicuous ant in the deep jungle is *Ectatomma tuberculatum*, which waits, solitary and patiently, on leaves for the approach of victims. Up and down the trunks travel the giant black *Neoponera* ants, the pain and swelling of whose sting last for many days. One fact, from the host which comes to the eye of the casual observer, is the specialized diet of some of these Ponerine ants, one of which feeds solely upon giant termites of the genus *Syntermes*.

Several times a year army ants clear our laboratory of all roaches and tarantulas, while, on the other hand, leaf-cutters render hopeless all our attempts at gardening—destroying both flowers and vegetables. Tiny red ants make it necessary to keep all fresh specimens on swinging shelves, but aside from this no ant disturbs or injures our possessions.

CHORDATA or VERTEBRATES

Within the small area set aside at the Tropical Research Station at Kartabo for intensive study, I have recorded eight hundred and eighteen species of vertebrates, almost exactly 60 per cent. of the total number so far known from the whole Colony of British Guiana. This may be taken as showing either the wide distribution of vertebrate forms of life and their abundance in a small area in the tropics, or it may indicate the very great number of species still to be discovered when intensive investigation similar to mine in my quarter of a square mile, is applied more widely. The truth lies probably between the two.

As the area under consideration is only one-three hundred and sixty thousandth ($1-360,000^{\text{th}}$) of British Guiana, this record is rather remarkable. It is as if there were found within half the area of the New York Zoological Park, or one quarter of Central Park, New York City, more than half of all the vertebrate animals of New York and Pennsylvania combined.

Among the invertebrates, the insects, and more especially ants, are by far the dominant forms; with vertebrates, birds are ahead to such an extent that there is relatively no second place. This is distinctly shown in the following table, together with other side-lights upon the general aspect of the back-boned animals of this limited area.

<i>Vertebrate Classes</i>	<i>No. of Species</i>	<i>Percentage of Whole</i>	<i>Number Indi- viduals</i>	<i>Dominant Visually</i>	<i>Dominant Vocally</i>	<i>Dominant in Color</i>	<i>Ex- tremes in Size</i>	<i>Danger to Man</i>
Fish	150	18.6%	1	5	5	3	2	2
Am- phibians	37	4.5%	2	3	2	4	5	5
Reptiles	93	11.4%	4	2	4	2	3	1
Birds	464	56.5%	3	1	1	1	4	4
Mammals	73	9%	5	5	3	5	1	3

THE FISH OF KARTABO

The study of the fish life in the research area at Kartabo has been made doubly delightful by constant reference to Dr. Carl H. Eigenmann's "Fresh-water Fishes of British Guiana." An additional source of interest lies in the fact that the Station is situated at the junction of the only two great rivers in the Colony which Eigenmann did not explore so that every capture or note which we make is certain to contribute a wholly new fact to our knowledge at least of the distribution of forms.

Within the few hundred yards included in the shallow water along the shore of our research area, and in one or two adjacent creeks, we have secured one hundred and fifty species of fish, rather more than one-third of the entire number secured by Dr. Eigenmann in his exploration of the Colony at large.

While the low mentality of fish is undoubtedly a fact, yet this is compensated by the interest of their great diversity of form and size, marvellous beauty and remarkable habits, and perhaps most of all by their vital suggestions of past evolution and the vivid evidence of evolution going on today, which they express in their bodies and their life habits.

As in the jungle, so the tropical waters teem with unexpected and strange organisms, and there is no level or niche left unexplored or unoccupied by one or more species of fish. I shall mention only a few of the many interesting aspects of fish life about the Station. In extremes of size we find schools of little sword-finned minnows close inshore, measuring less than an inch in length, while farther out, great lau-lau catfish swim about, brobdignagian bull-heads six to twelve feet in length, with grinning mouths two feet wide. They

will occasionally take the hook but put up no more fight than would a barrel of cement. The largest fresh-water fish in the world and one of the most gamey also inhabits Guiana waters, the arapaima, which reaches a length of fifteen feet and a weight of over four hundred pounds. We have, however, not yet taken it at the Research Station. The flesh of all these fish is most delicate.

Many of the fish are very beautiful, but on the whole there is hardly an average of greater brilliancy of pigment than in the fishes of temperate waters. Scarlet eels and golden catfish with fins of flame-color are astonishing when they swim up through the brown water; and many-colored ocelli or eyed spots are rather common both on fins and bodies. As to variety of form there is no end. To take mouths alone, there is the elongated tube of the pipefish, the swordfish-like needlefish and the halfbeak with its minute upper mandible and enormously lengthened under jaw. Most frightful looking fish come up in the seine, such as the silvery biara or dog-toothed fish, with teeth so long that they pass clear through the head and project into the water above, yet which is a fish wholly innocuous; on the other hand a meek appearing sunfish is in reality the notorious perai, one of the most dangerous of all fishes. Nothing more hopeless can be imagined than to be attacked by a school of these razor-toothed little fiends.

The sand gobies, when frightened, flatten out on the bottom, and draw over themselves a mantle of color identical with that of their background; the comical green- and black-banded puffers, on the contrary, distend themselves with air into a taut, skinny, inedible ball, and float out of reach upon the surface until danger is past.

The fish about Kartabo show three important radiations; first, intrusions from the salt water of the open sea, fifty miles away by water line; second, aerial attempts, and third, terrestrial trials. As unexpected intrusions from the sea we find the gobies and the young gar or needlefish is also essentially marine. Most remarkable are the sting rays, two species of which have deserted salt water and inhabit our rivers. The last ocellated ray which we caught on a set line, gave birth to five young rays in the boat; in an aquarium the little rays flapped slowly about on the sandy bottom and the back of the mother.

The four-eyed fish is also essentially a lover of salt or brackish water but occasionally it enters the fresh waters about Kartabo. It is, however, as an invader of the air that it holds greatest interest,

the upper part of the eyes being modified for atmospheric vision, while it appears unable to dive more than a foot or two beneath the surface. The second aerial aspirant is the fresh-water flying fish, built rather on the lines and method of operation of a hydroplane than an airplane, as it rises with a rush and slithers along the surface, its deep keel usually cutting a tiny furrow as it goes.

The piscine land invaders are of extreme interest, both on account of their individual specializations and their evolutionary significance. When a pool forms after a heavy rain, deep within the jungle, or on a hillside well away from water, it soon contains fish as well as tadpoles and whirligig beetles; fish not descended with the rains, as the old legend has it, but which have scrambled and leaped and finned their way from the abundance of their element in the great rivers to this meagre, temporary cupful of water in the midst of a host of terrestrial dangers. Why the impulse comes to them, or to them and not to many others, we cannot even imagine.

Other land-loving fish are the primitive hassas or armored catfish, which come out at low tide and flip about the mud, regardless of sun or drought. These and the marsh eels are most unsatisfactory aquarium fish, for they are continually climbing out and seeking the seclusion of dusty corners. I may here only mention the astounding electric eel with its double dynamos of living flesh, and the nurse fish, whose young find sanctuary by the half hundred in the mouths of their parents.

While there is no lack of fish, large and small, near the Station, yet the least successful method of capture is by rod and line. This is due to several reasons, chief among which is the low visibility of the brown jungle water, combined with the abundance of natural food which the fish find ready at hand. Fish hold an important place in the diet of the Indians about Kartabo and they are skilful in shooting them with bow and arrow, poisoning and trapping them. They know the exact edibility of the various species and of the poisonous parts of specific ones such as the liver of the large catfish. They have names for almost all and even distinguish between forms which bear a very close superficial resemblance.

Our collections have been made almost altogether by means of set lines and seining.

Within the research area I have a record of forty-seven species of vertebrates feeding on fish, of which about half probably devour no other forms of life. If several more thousands of stomachs could

be examined this number would be considerably increased, especially among the fishes themselves. These enemies of fish vary from creatures like the snakebird, kingfisher and dolphin which seem fundamentally adapted for a piscine diet, to the kiskadee flycatcher which has only recently taken to fishing.

The piscivorous vertebrates of Kartabo are as follows:

Fish	12	Birds	26
Amphibia	1	Mammals	3
Reptiles	5		

The remarkably general distribution among varied orders of vertebrates is well indicated in the following list:

Class PISCES

Order	Genera
Batoidea	<i>Potamotrygon</i>
Nematognathi	<i>Paulicea</i> <i>Brachyplatystoma</i> (3 sp.) <i>Ageniosus</i>
Heterognathi	<i>Serrasalmo</i> <i>Hydrolicus</i> <i>Cynopotamus</i> <i>Hydrocynus</i>
Symbranchii	<i>Symbranchus</i>
Percomorphi	<i>Plagioscion</i>

Class AMPHIBIA

Cystignathidae	<i>Leptodactylus</i>
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Class REPTILIA

Boidae	<i>Eunectes</i>
Ilysiidae	<i>Ilysia</i>
Colubridae	<i>Hydrops</i>
Elapidae	<i>Micrurus</i>
Crocodylidae	<i>Caiman</i>

Class AVES

Ralliformes	<i>Heliornis</i>
Lariformes	<i>Phaetusa</i> <i>Sterna</i> (2) <i>Rhynchops</i>

Gruiformes	<i>Mycteria</i>
Ardeiformes	Herons (11)
Pelicaniformes	<i>Phalacrocorax</i>
	<i>Anhinga</i>
Accipitriformes	<i>Pandion</i>
Coraciiformes	Kingfishers (5)
Passeriformes	<i>Pitangus</i>

Class MAMMALIA

Marsupialia	<i>Chironectes</i>
Carnivora	<i>Lutra</i>
Odontoceti	<i>Inia</i>

Class PISCES

Order BATOIDEA

Family PRISTIDAE

Sawfish Rays: There are four records of sawfishes caught at Kartabo before our first arrival, and twice during our absence twelve-inch individuals have been secured by Indians in creeks. This is distinctly a marine intrusion, with the precedent of what is probably the same species ascending the Mississippi for a considerable distance.

Family DASYATIDAE

Sting Rays: Strictly marine rays are found abundantly in the lower Essequibo, but from Bartica up, two species of fresh-water rays occur, one rather commonly. Five miles higher, above the rapids and from there for many miles up river these are numerous and a constant source of danger to gold and diamond seekers. The mucous of these fresh-water forms seems more virulent than that of the sea rays. Both species have been taken at Kartabo, and the young to the number of five been born alive in captivity. They are carnivorous bottom feeders, taking worms, small fish, shrimps and drowned organisms.

Order NEMATOGNATHI

Fresh-water catfish are especially characteristic of the Amazon and Guiana regions. Thirty-four species have been found at the Station, divisible into five families.

Family SILURIDAE

Twenty species belong under this family. Among them are the common bottom or mid-water forms, one of which, a *Pimelodus* locally known as Larima is actually abundant. These are of small or moderate size, but in this same genus are the giants of these waters, such as *Brachyplatystoma*, the lau-lau, which ranges from a length of not uncommonly seven feet, to reputed giants of twelve feet.

The smaller catfish are mostly bottom feeders and embrace in their diet worms, small fish, mollusks, shrimps and hosts of drowned terrestrial insects. The giant mid-water forms feed altogether on medium-sized fish, and spend most of their time well out from shore where they can be caught on strong set lines at night. Occasionally however they come close in and can be heard grunting and booming among the rocks and mangroves.

Family HELOGENIDAE

A single, small, mottled catfish of this family is occasionally taken in jungle creeks.

Family PYGIDIIDAE

Two species, one quite eel-like in shape, also occur in creeks.

Family CALLICHTHYIDAE

Three species of these interesting armoured catfish occur, all feeding on muddy vegetable debris.

Family LORICARIIDAE

Seven species of this family show two general types of structure, one of which, *Loricaria*, is exceedingly flattened for a strictly bottom life, while *Plecostomus* is triangular in transverse section and is almost as much at home on the mud of the shore as in the water. All feed on vegetable debris and small organisms. *Plecostomus* is eaten by the small river cormorants.

Order HETEROGNATHI

Family CHARACIDAE

In number of forms and variety of types the Characins of Kartabo may be compared with the Passerine group of birds. We have collected fifty-one species, comprising nearly forty per cent of the entire fish fauna. These are distributed through seventeen families.

Many are very small and inconspicuous looking fish, and among them are the most abundant shore forms. None are true bottom dwellers but are found in mid-water and on the surface, chiefly in creeks or along the shore. A few are brilliantly colored. Several have enormously developed canine teeth and are aquatic wolves; the notorious Perai has moderate teeth but is the most dangerous, fiercest fish here, if not in the world. Its closest relative is a harmless vegetarian. The fresh-water flying fish are Characins, skimming for long distances along the surface. A few of the larger species form the chief food of the Indians. Worms, insects, shrimp and other fish form the principal items of diet of these fish.

Order GLANENCHALI

Family GYMNOTIDAE

The eels of Kartabo number eight species distributed unequally among four subfamilies. All are interesting forms but the electric eel is preeminent, and specimens over five feet in length have been taken. We have occasionally had a shock transmitted by the water when swimming but any danger is imaginary. It feeds on shrimp, tadpoles, fish and other small organisms and except when small is found in the open river. The other eels are inhabitants chiefly of jungle creeks and several are brilliantly colored. They feed on shrimp, caddis-worms and insects.

Order SYMBRANCHI

Family SYMBRANCHIDAE

This eel in appearance and habits resembles so closely the limbless amphibian *Typhlonectes* that we considered it as such for a long time. It lives in swamps and in the mud along shore, and forms the chief food of coral snakes and of two of their mimics. It feeds in turn on fish and crabs.

Order ISOSPONDYLI

Family ENGRAULIDAE

Two small species of *Stolephorus* are found along the shore, one very abundantly. They are small, silvery fishes with such delicate, deciduous scales that the least touch dislodges a shower. A species of *Lycengraulis* is considerably larger than the two preceding. The food is minute insects and entomostracans.

Order MICROCYPRINI

Family POECILIDAE

Five interesting small fish represent this minnow-like family. *Rivulus* is the most terrestrial of all the Kartabo fish fauna, and is found in isolated rain pools deep in the jungle, a half mile or more away from the river. *Anableps* is essentially a salt-water form, the Four-eye adapted equally well to see under water as well as in the air. Three small ones among the mangroves are all we have on record at the Station.

The Sword-finned Minnow, *Tomeurus*, is a very abundant and persistently littoral form, with the male showing most remarkably specialized sexual characters. Entomostracans form their principal food.

Order SYNENTOGNATHI

Family BELONIDAE

A small gar-like fish is very rare at Kartabo.

Family HEMIRHAMPHIDAE

A curious fish, with enormously elongated under jaw, and a short stump of an upper jaw, lives along the shore and feeds on spiders, gnats and small mollusks.

Family ESOCIDAE

There is one record of a *Tylosaurus*.

Order LOPHOBANCHII

Family SYNGNATHIDAE

A small pipe-fish is not uncommon. All the specimens secured have been females with the ventral brood pouch filled with eggs more or less advanced in development.

Order PERCOMORPHI

Family CICHLIDAE

An interesting family of which seven species are present. *Geophagus* is common along shore, the parents sheltering the young fish in their mouths in time of danger. *Crenicichla*, a very brightly colored carnivorous form, lives in mid-water.

Family SCIAENIDAE

Three species, one of which, *Plagioscion*, is very common and an important food-fish.

Family POLYCENTRIDAE

One small, vertically flat, black, changeable colored fish of the deep jungle is occasionally found.

Family GOBIIDAE

Three very common forms of sand gobies. One, an *Eleotris* with most remarkable color changes, spends much time in the open air or in small tide-pools. Two sand gobies are found intensively associated, resembling each other in size, shape, general sandy pattern, carnivorous habit, yet belonging to very distinct genera—*Evorthodus* and *Awous*.

Order HETEROSOMATA

Family PLEURONECTIDAE

A small species of flounder is rare and very local in distribution. Native fishermen say that it was first found here four years ago, so is evidently a recent invasion. Nothing has been found in its stomach but sponge spicules and Chironomid larvae.

Family SOLEIDAE

Two species, of which one, a small flounder of the genus *Achirus*, is somewhat more common than the other, all the specimens being under three inches in length.

Order PLECTOGNATHI

Family TETRADONTIDAE

A small, green- and black-banded puffer is common along shore. It also occurs as a surface feeder out in the open river and is especially numerous at the mouths of jungle creeks. It is an omnivorous feeder, and is fed upon by *Ardea cocoi*.

FISH STOMACH CONTENTS

Sponge Spicules—	<i>Pimelodus clarias</i> <i>Achirus fasciatus</i>
Worms—	<i>Potamotrygon hystrix</i> <i>Leporinus arcus</i> <i>Poecilurichthys abramoides</i> <i>Gymnotus carapo</i>
Oligochaetes—	<i>Hemidoras carinatus</i> <i>Leporinus nigrotaeniatus</i> <i>Pristella riddlei</i> <i>Gymnotus carapo</i> <i>Eigenmannia virescens</i> <i>Gymnorhamphichthys hypostomus</i>

Fish stomach contents—continued

Leeches—	<i>Stolephorus surinamensis</i>
Mollusks—	<i>Pimelodus clarias</i> <i>Megalodoras</i> sp. <i>Hyporhamphus roberti</i> <i>Colomesus psittacus</i>
Entomostracans—	<i>Stolephorus surinamensis</i>
Daphnia—	<i>Stolephorus surinamensis</i> <i>Tomeurus gracilis</i>
Cyclops—	<i>Hemidoras carinatus</i> <i>Stolephorus surinamensis</i>
Isopods—	<i>Sternopygus macrurus</i>
Shrimps—	<i>Potamotrygon hystrix</i> <i>Pimelodus clarias</i> <i>Pimelodus ornatus</i> <i>Chalcinus rotundatus</i> <i>Hydrolicus scomberoides</i> <i>Electrophorus electricus</i> <i>Gymnorhamphichthys hypostomus</i> <i>Stolephorus surinamensis</i> <i>Plagioscion auratus</i> <i>Crenicichla alta</i>
Crabs—	<i>Pimelodus clarias</i> <i>Symbranchus marmoratus</i>
Crustaceans—	<i>Pimelodus clarias</i> <i>Pimelodus ornatus</i> <i>Leporinus alternus</i> <i>Poecilurichthys abramoides</i> <i>Stolephorus surinamensis</i> <i>Tomeurus gracilis</i> <i>Colomesus psittacus</i>
Chelifera—	<i>Pimelodus clarias</i> <i>Hemidoras carinatus</i>
Spiders—	<i>Leporinus alternus</i> <i>Chalcinus rotundatus</i> <i>Tomeurus gracilis</i> <i>Hyporhamphus roberti</i> <i>Colomesus psittacus</i>
Mites—	<i>Hemidoras carinatus</i> <i>Leporinus nigrotaeniatus</i> <i>Eigenmannia virescens</i>
Millipedes—	<i>Pimelodus clarias</i> <i>Leporinus nigrotaeniatus</i>

Fish stomach contents—continued

Dragonfly Larvae—	<i>Sternopygus macrurus</i> <i>Gymnorhamphichthys hypostomus</i> <i>Plagioscion auratus</i>
Orthoptera—	<i>Colomesus psittacus</i>
Roaches—	<i>Potamotrygon hystrix</i> <i>Rhamdia sebae</i> <i>Chalceus macrolepidoptus</i> <i>Cynopotamus essequibensis</i>
Hemiptera—	<i>Hemidoras carinatus</i> <i>Leporinus arcus</i> <i>Creatochanes caudomaculatus</i> <i>Hyporhamphus roberti</i>
Moths—	<i>Chalcinus rotundatus</i>
Caterpillars—	<i>Potamotrygon hystrix</i>
Caddis Larvae—	<i>Hemidoras carinatus</i> <i>Leporinus arcus</i> <i>Sternopygus macrurus</i> <i>Eigenmannia virescens</i> <i>Colomesus psittacus</i>
Diptera—	<i>Rhamdia sebae</i> <i>Pimelodus ornatus</i> <i>Hemidoras carinatus</i> <i>Creatochanes affinis</i> <i>Creatochanes caudomaculatus</i> <i>Holobrycon pesu</i> <i>Gasteropelecus sternicla</i> <i>Sternopygus macrurus</i> <i>Stolephorus surinamensis</i> <i>Rivulus stagnatus</i> <i>Tomeurus gracilis</i> <i>Hyporhamphus roberti</i> <i>Plagioscion auratus</i> <i>Geophagus surinamensis</i> <i>Evorthodus breviceps</i>
Chironomids—	<i>Pimelodella cristata</i> <i>Pimelodus clarias</i> <i>Pygidium guianensis</i> <i>Stolephorus surinamensis</i> <i>Geophagus jurupari</i> <i>Achirus fasciatus</i> <i>Colomesus psittacus</i>
Neuropterous Larvae—	<i>Pygidium guianensis</i> <i>Chalceus macrolepidotus</i>

Fish stomach contents—continued

Electrophorus electricus
Sternopygus macrurus
Gymnorhamphichthys hypostomus
Stolephorus surinamensis

Beetles—

Hemicetopsis macilentus
Leporinus nigrotaeniatus
Moenkhausia grandisquamis
Creatochanes affinis
Poecilurichthys abramoides
Holobrycon pesu
Chalcinus rotundatus
Carnegiella strigata
Gasteropelecus sternicla
Myloplus rubripennis
Cynopotamus essequibensis
Gymnotus carapo
Eigenmannia virescens
Eleotris amblyopsis

Ants—

Pimelodus clarias
Leporinus alternus
Tetragonopterus chalceus
Moenkhausia grandisquamis
Pristella riddlei
Creatochanes affinis
Creatochanes caudomaculatus
Poecilurichthys abramoides
Holobrycon pesu
Chalceus macrolepidoptus
Chalcinus rotundatus
Carnegiella strigata
Myloplus rubripennis
Gymnotus carapo
Sternopygus macrurus
Rivulus stagnatus
Hyporhamphus roberti
Crenicichla lugubris
Colomesus psittacus

Muddy Debris—

Potomotrygon hystrix
Pimelodus clarias
Callichthys callichthys
Hoplosternum thoracatum
Corydoras punctatus
Plecostomus plecostomus
Hemiancistrus braueri
Xenocara gymnorhynchus

Fish stomach contents—continued

Ancistrus sp.
Loricaria cataphracta
Loricariichthys griseus
Loricariichthys stewarti
Electrophorus electricus
Geophagus surinamensis
Geophagus jurupari
Eleotris amblyopsis

Vegetable Matter—

Pimelodella cristata
Hemisorubim platyrhynchos
Doras granulosus
Hemidoras carinatus
Trachycorystes obscurus
Hemicetopsis macilentus
Bivibranchia protractila
Curimatus spilurus
Curimatus schomburgki
Prochilodus rubrotaeniatus
Anastomus anastomus
Laporinus nigrotaeniatus
Laporinus alternus
Poecilurichthys abramoides
Holobrycon pesu
Brycon falcatus
Myloplus rubripinnis
Myloplus rhomboidalis
Myleus pacu
Electrophorus electricus
Gymnotus carapo
Gymnorhamphichthys hypostomus
Rivulus stagnatus
Hyporhamphus roberti
Geophagus surinamensis
Colomesus psittacus

Seeds—

Doras granulosus

Algae—

Anisitsia notata
Leporinus fasciatus
Cretochanes affinis
Myleus pacu
Symbranchus marmoratus
Eleotris amblyopsis
Colomesus psittacus

Fish—

Potamotrygon hystrix
Paulicea lutkeni

Fish stomach contents—continued

- Brachyplatystoma rousseauxi*
- Brachyplatystoma vaillianti*
- Ageniosus marmoratus*
- Serrasalmo rhombeus*
- Hydrolicus scomberoides*
- Cynopotamus essequibensis*
- Hydrocynus cuvieri*
- Symbranchus marmoratus*
- Plagioscion auratus*
- Crenicichla lugubris*
- Eleotris amblyopsis*

Tadpoles—

- Electrophorus electricus*

Class AMPHIBIA

In the quarter mile of research area I have found thirty-seven certainly identified species of Amphibians, together with eight additional species represented only by tadpoles or other insufficient material. The thirty-seven species are grouped in two orders and seven families. One of the most remarkable facts about this Class is the total absence of Urodeles. As far as we know not a single newt or salamander is found in the entire Colony.

Apoda, the first order, with a single family Coecilidae, is represented in my restricted area by only one species, *Siphonops annulatus*, a legless, earthworm-like amphibian. It is a burrowing form, apparently very rare, and in its structure a most remarkable combination of ancestral and specialized characters.

The comparative relationships of the six families of Anura, the toads and frogs, is shown in this table:

	Families	No. of Species	Relative number of Individuals	Relatively dominant Visually	Relatively dominant as to Color	Relatively dominant as to Style	Relatively dominant Aurally
1	Pipidae	2	6	6	6	6	6
2	Bufonidae	3	4	1	5	1	3
3	Hylidae	11	2	3	1	3	1
4	Cystignathidae	11	1	2	3	2	4
5	Engystomatidae	4	5	5	4	5	5
6	Ranidae	5	3	4	2	4	2

Order ANURA

Family PIPIDAE

The classic Surinam Toad is confined to the Guianas and the adjacent portion of Brazil, but heretofore has been found only on the coast and not in the interior. Up to the present two individuals only of *Pipa americana* have been recorded from the research area, one full-grown. In March 1924 I made a search for Pipas in the pool where a small species was found two years preceding, and although it was almost dried up I discovered five, one large female, a smaller male and three small ones. Later in the year several breeding females were found by Dr. Emerson, and the species confirmed as a second, small member of the genus, *Pipa aspera*.

Family BUFONIDAE

Three toads inhabit this area, two of them common. One of these, the Marine Toad, might be termed familiar, for it lives about, and even in and under the laboratory, and offers little objection to capture and handling. Its catholicity of taste in diet is astonishing, quite as much so as its almost complete lack of enemies.

Were mankind an important factor in this area, this toad would be of the utmost value, for it feeds on the most noxious insects. In the stomach of a medium-sized individual over seven hundred *Attas* or leaf-cutting ants were found, besides fifty other ants, millipedes, centipedes and scorpions. The very young toads devour ticks, mites and *bête rouge*. The deep-throated, continuous roar of these frogs is heard off and on throughout the year, but is at its height during the first part of the rainy seasons. The sound carries over a mile across the water. The Marine Toad excels all other Kartabo amphibians in size, reaching a weight of one and one-half pounds, and in vocal power is surpassed only by the Giant *Hyla*.

Family HYLIDAE

The tree-toads form one of the most characteristic and interesting tropical families of amphibians. Eleven species have been found in the research area. Probably one-third as many more remain to be discovered when the tree-tops and the ultimate leaves of the deep jungle have yielded their batrachian secrets. The most brilliant colors are found here and voices which far outdo all other sounds of the night. *Hyla rubra* is the familiar of this group, coming into the laboratory and depositing its eggs in our aquariums and vivariums.

Family CYSTIGNATHIDAE

In this family are included eleven frogs varying in form from the amazing huge-headed *Ceratophrys* and the nine-inch tadpole of *Pseudis* to the tiny *Leptodactylus minutus*. Those of the genus *Leptodactylus* are strong, fierce creatures, never reconciled to captivity, cannibals on occasion, with many strange habits such as uttering an appalling scream when captured.

Family BREVICIPITIDAE

Four anomalous species, chiefly walkers, and except *Atelophus*, swamp burrowers, extremely difficult to find. All are rare.

Family RANIDAE

Two little leaf-walkers are common and noisy in the rains, the male *Dendrobates* carrying the tadpoles about upon his back. The green Guiana Bull-frog is found along the shore and also deep in the jungle.

ENEMY AND PREY ECOLOGY

Enemies of Amphibians

Twenty species of vertebrates have been found to prey on Amphibians:

Two fish—*Plagioscion* and *Serrasalmo*.

Four amphibians devour their own kind, three species of *Leptodactylus*, while the tadpoles of *Phyllomedusa* aggressively attack and devour other species of tadpoles.

Seven species of snakes, *Herpetodryas* (2 sp.), *Bothrops* (2 sp.), *Liophis*, and *Xenodon* (2 sp.), feed on seven species of *Anura*.

Five birds, *Europyga*, *Theristicus*, *Ardea*, *Cochlearius* and *Urubitinga*.

Two mammals, *Lutra* and *Nasua*.

AMPHIBIAN STOMACH CONTENTS

Isopods—	<i>Leptodactylus pentadactylus</i> <i>Phyllobates inguinalis</i> <i>Dendrobates</i>
Scorpions—	<i>Leptodactylus pentadactylus</i>
Crabs—	<i>Hyla maxima</i>

Amphibian stomach contents—continued

Pseudoscorpions—	<i>Dendrobates</i>
Harvestmen—	<i>Bufo marinus</i>
Spiders—	<i>Bufo marinus</i> <i>Leptodactylus caliginosus</i> <i>Phyllobates inguinalis</i>
Acarina—	<i>Bufo marinus</i> <i>Bufo marinus</i> (newly hatched)
Myriopods—	<i>Bufo marinus</i> <i>Dendrobates</i> <i>Leptodactylus pentadactylus</i>
Chilopods—	<i>Bufo typhoni</i>
Insecta—	
Thysanura—	<i>Leptodactylus pentadactylus</i> <i>Dendrobates</i>
Isoptera—	<i>Hyla pardalis</i> Yellow green <i>Hyla</i> <i>Leptodactylus caliginosus</i> <i>Gastrophryne ovale</i> <i>Atelopus flavescens</i> <i>Gastrophryne microps</i> <i>Phyllobates inguinalis</i>
Orthoptera—	<i>Bufo marinus</i> <i>Hyla pardalis</i> <i>Hyla rubra</i> <i>Leptodactylus caliginosus</i> <i>Leptodactylus mystacinus</i> <i>Leptodactylus stictigularis</i> <i>Leptodactylus pentadactylus</i> <i>Phyllobates inguinalis</i> <i>Hyla maxima</i> <i>Hyla albomarginata</i>
Hemiptera—	<i>Bufo marinus</i> <i>Leptodactylus pentadactylus</i> <i>Leptodactylus caliginosus</i> <i>Leptodactylus mystacinus</i>
Membracids—	<i>Phyllobates inguinalis</i> <i>Hyla albomarginata</i>
Lepidoptera—	<i>Hyla rubra</i>

Amphibian stomach contents—continued

Diptera—	<i>Bufo marinus</i> <i>Bufo guttatus</i> <i>Leptodactylus caliginosus</i>
Coleoptera—	<i>Bufo marinus</i> <i>Bufo typhonius</i> <i>Bufo guttatus</i> <i>Hyla rubra</i> <i>Hyla boans</i> <i>Leptodactylus lineatus</i> <i>Leptodactylus pentadactylus</i> <i>Leptodactylus caliginosus</i> <i>Leptodactylus mystacinus</i> <i>Leptodactylus rhodomystax</i> <i>Phyllobates inguinalis</i>
Hymenoptera—	
Ants—	<i>Bufo marinus</i> (a. 700 Attas, 50 <i>Pachycondyla</i> .) (b. 400 Attas.) <i>Bufo typhonius</i> <i>Bufo guttatus</i> <i>Hyla rubra</i> <i>Leptodactylus caliginosus</i> <i>Leptodactylus mystacinus</i> <i>Gastrophryne microps</i> <i>Dendrobates</i> <i>Phyllobates inguinalis</i>
Hymenoptera—	
Wasps—	<i>Bufo marinus</i> <i>Leptodactylus stictigularis</i>
Vertebrates—	
Frogs—	<i>Leptodactylus pentadactylus</i> <i>Leptodactylus caliginosus</i> <i>Leptodactylus stictigularis</i> <i>Phyllomedusa bicolor</i> (tadpoles carnivorous)

Class REPTILIA

Within the research area at Kartabo I have collected ninety-three species of reptiles. Although there is no special list of the reptiles of British Guiana, in literature I find mention of one hundred and twenty forms. Hence over seventy-seven percent of this colonial total is represented in the quarter mile under observation.

Four orders are included and nineteen families, and there undoubtedly remain many more species as yet undetected.

	Number of Families	Number of Species	Relative Number of Indi- viduals	Relative Domi- nance Visually	Relative Color Domi- nance	Relative Extreme in Size	Relative Danger to Man
I—Testudinata	5	8	III	III	III	IV	—
II—Crocodilia	1	2	IV	IV	IV	II	II
III—Lacertilia	5	31	I	I	II	III	—
IV—Serpentes	6	52	II	II	I	I	I

Class REPTILIA

Order TESTUDINATA

Tortoises and turtles form a very unimportant group of Kartabo organisms, both in number of species and in specimens. Five families are represented, and eight species.

Family CINOSTERNIDAE

Cinosternum scorpioides: This species appears to be confined to Guiana and is the only South American representative of the family of our common mud turtle of New York. Only two small specimens have been found in the research area.

Family TESTUDINIDAE

Nicoria punctularia: This turtle is not rare, a half dozen being found in the creeks each season.

Testudo denticulata: This bright-colored land tortoise is the only common Chelonian in the area, and is frequently to be found wandering about in the jungle, in both dense and open growths. They reach an unusually large size, over two and a half feet in length of shell, but apparently breed when quite small. I have heard them utter musical grunts during the breeding season. Three times they have been found freshly scooped out of their shells, probably the work of an ocelot or jaguar.

Family CHELONIDAE

Chelonia mydas: Only two sea turtles have been recorded, both very small, one from below and the other just up-river from the station. The eggs of this species are common in sand banks in the Essequibo above Bartica, where they are dug out and eaten by the Indians.

Family PELOMEDUSIDAE

Podocnemis unifilis; *Podocnemis expansa*: Two young specimens and one adult of the first species, and a single adult of the second taken from the jungle creeks.

Family CHELYDIDAE

Chelys fimbriata: No mata-mata has been found within the exact research area but there are records a very short distance away to the north in Cauria Creek (two specimens reported by warder and convicts), one medium specimen east, from Kalacoon, and one from the south, just this side of Ororabo. The largest measured was eighteen inches, the smallest five and a half inches in length.

Platemys platycephala: The flat-shelled turtle is found only at the mouth of jungle creeks. Several six-inch individuals have been taken north alive.

Order CROCODILIA

Family CROCODYLIDAE

Caiman niger: The giant black crocodile of the upper reaches of the rivers of Guiana has been seen only twice near the Station. A ten or twelve foot specimen spent several days on a ledge of rocks a few hundred yards from the laboratory in 1920, and a second was observed by me on the shore some distance up the Cuyuni.

Caiman sclerops: The common crocodile of the rivers hereabouts. Four or five foot individuals nest in the trenches about the Penal Settlement, and small ones are occasionally taken in fishermen's nets near the Station. A young male three feet long and weighing five pounds had the following in its stomach:

Many small, white quartz stones,
Two large spiders,
Fifteen lizard and fish bones,
Three pieces of half-burned wood.

Order LACERTILIA

The lizards of the Kartabo quarter square mile, as in most places in the tropics, are an important group. Of the four orders of Reptilia they are first in point of number of individuals and visual dominance, second in species and brilliance of color, and third in extreme size.

Thirty-one species have been identified with certainty, varying in size from tiny geckos an inch and a half in total length to iguanas



Fig. 12. A jungle Anolis; one of the common lizards.
Photograph by John Tee-Van.

over six feet from snout to tail-tip. These are scattered through five families, of which Iguanidae has ten and Teiidae sixteen species. Twenty-one genera complete the group divisions.

While there is considerable change of color among a number of species, yet the pigmentation as a rule, both as to pattern and color, reflects the particular haunts of the various species. The ground forms, like *Mabuia*, are brown, or ruptively colored green and brown as *Ameiva*. The trunk-loving forms are grey as in *Ophryoessa*, or brown like the Geckos, and the foliage-haunting species are green, such as *Iguana*, *Polychrus*, *Plica* and some *Anoli*. The burrowing lizards such as *Amphisbena* are white, black or irregularly blotched.

In distribution the lizards of Kartabo range from the topmost branches of trees to several yards underground. Only one form is adaptively aquatic, although most can swim readily when need arises. The following represents in a general way the zone in which the various genera are usually found:

AQUATIC	<i>Neusticurus</i>
BURROWING	<i>Cophias</i> <i>Amphisbena</i>
TERRESTRIAL	
Jungle	<i>Tupinambis</i> <i>Iphisa</i> <i>Leposoma</i> <i>Mabuia</i>
Near Clearings	<i>Ameiva</i> <i>Cnemidophorus</i> <i>Prionodactylus</i>
ARBOREAL	
Logs and Hollow Trees	<i>Gonatodes</i> <i>Thecadactylus</i> <i>Sphaerodactylus</i>
Low Trunks and Branches	<i>Anolis</i> (brown) <i>Tropidurus</i> <i>Centropyx</i> <i>Ophryoesa</i>
Trunks, Mid-Jungle	<i>Plica</i>
Foliage, Mid-Jungle	<i>Polychrus</i>
Foliage, Low-Jungle	<i>Anolis</i> (green)
Near Creeks and Clearings	<i>Iguana</i>
IN HOUSES	<i>Thecadactylus</i> <i>Sphaerodactylus</i>

As regards occurrence no species in undisturbed environment can be said to be abundant. The numbers of the two Geckos in the laboratory itself and the young Ameivas and Cnemidophorus which scamper about the compound are adaptations to the altered conditions induced by our occupation. In the jungle the brown forms of Anolis and the two clearing lizards mentioned are common, but all others are occasional or rare.

ENEMY AND PREY ECOLOGY

Lizards are eaten by at least thirteen vertebrates in the quarter mile under observation, these being three snakes, nine birds and one mammal. All three species of the Cotingine genus *Attila* feed to a

large extent on small lizards, as does the Furnarian *Automolus*. The two hawks *Leucopternis* and *Gampsonyx* devour *Cnemidophorus*, as does the snake *Oxybelis*, while *Elanoides* catches *Polychrus*, *Harpagus* eats *Anolis*, and *Boa constrictor* and *Clelia* kill *Ameiva*. The coati-mundi, *Nasua*, takes lizard eggs whenever he finds them, and in one individual I found three of the rare *Cophias flavescens*.

Of the thirty species of lizards only one is a strict vegetarian. This is *Iguana*, while *Polychrus* eats berries and leaves as often as animal food. The only vertebrates so far found in a lizard's diet are *Cnemidophorus* and the spiny rat, *Proechimys*, eaten by *Tupinambis*.

LIZARD DIET

Leaves	<i>Iguana</i> <i>Polychrus</i>
Berries	<i>Polychrus</i>
Earth Worms	<i>Anolis</i>
Mollusks	<i>Thecadactylus</i>
Crabs	<i>Tupinambis</i>
Isopods	<i>Cophias</i>
Millipedes	<i>Plica</i> <i>Ophryoesa</i>
Centipedes	<i>Anolis</i> <i>Plica</i>
Acarina	<i>Thecadactylus</i>
Spiders	<i>Tupinambis</i> <i>Anolis</i>
Cicadas	<i>Plica</i>
Moth Flies	<i>Thecadactylus</i>
Mosquitoes	<i>Anolis</i>
Crane Flies	<i>Leposoma</i>
General Diptera	<i>Thecadactylus</i>
Termites	<i>Anolis</i> (two species) <i>Thecadactylus</i>
Wood Roaches	<i>Sphaerodactylus</i> <i>Anolis</i> <i>Thecadactylus</i>

Lizard diet—continued

Mole Crickets	<i>Amphisbena</i> <i>Anolis</i>
Long-Horned Grasshoppers	<i>Polychrus</i> <i>Tupinambis</i> <i>Plica</i>
Beetles	<i>Plica</i> (two species) <i>Polychrus</i> <i>Tupinambis</i> <i>Centropyx</i> <i>Amphisbena</i> <i>Thecadactylus</i> <i>Anolis</i> <i>Cophias</i>
Microlepidoptera	<i>Cophias</i>
Caterpillars	<i>Anolis</i> <i>Ophryoesa</i>
Wasps	<i>Tupinambis</i>
Ants	<i>Anolis</i> (two species) <i>Plica</i> (two species) <i>Tupinambis</i> <i>Cophias</i> <i>Thecadactylus</i>
Cnemidophorus	<i>Tupinambis</i>
Spiny Rat	<i>Tupinambis</i>

I have omitted the two most abundant species of lizards, *Ameiva* and *Cnemidophorus*, from this list, in order to demonstrate the wide range of diet of these ground saurians, and the interesting comparison of relative numbers. I have selected forty individuals of each and have ranged the items of diet in the order of their number of occurrences:

Diet of Two Lizard Species

<i>Ameiva</i>		<i>Cnemidophorus</i>	
Roaches	18	Beetles	18
Beetles	16	Grasshoppers	15
Grasshoppers	14	Spiders	13
Centipedes	9	Wasps	11
Spiders	8	Caterpillars	7
Scorpions	7	Ants	5

Diet of two lizard species—continued

Ants	7	Flies	5
Snails	4	Roaches	4
Millipedes	4	Crickets	3
Termites	4	Heteroptera	3
Mantids	3	Bees	3
Caterpillars	3	Beetle larvae	2
Diptera	3	Centipedes	2
Dipterous larvae	2	Snails	2
Crickets	2	Fruit	2
Earth worms	1	Cnemidophorus tails	1
Earwigs	1	Butterflies	1
Hemiptera	1	Membracids	1
Wasps	1	Termites	1
		Dragonflies	1
		Mole crickets	1
		Crabs	1
		Flowers	1

The breeding of the lizards of Kartabo, when charted, resolves into two unequal nodes, both occurring at the end of the rains, or the beginning of the dry seasons. April, May, October and November are the low months, and January, July and August the high ones, the latter being the month of intensest breeding by several hundred per cent. The latitude of breeding throughout the year is probably considerably greater than is apparent from my records. *Anolis* shows the following relative mensual percentages of breeding records:

January	10 per cent.	July	10 per cent.
February	20 " "	August	30 " "
March	10 " "	November	10 " "
April	10 " "	December	20 " "

The monthly distribution by genera follows:

January	<i>Anolis</i>	June	<i>Tupinambis</i>
	<i>Polychrus</i>		<i>Leposoma</i>
	<i>Iguana</i>		<i>Cophias</i>
February	<i>Anolis</i>	July	<i>Gonatodes</i>
March	<i>Anolis</i>		<i>Thecadactylus</i>
	<i>Leposoma</i>		<i>Sphaerodactylus</i>
April	<i>Anolis</i>		<i>Anolis</i>
May	<i>Leposoma</i>		<i>Polychrus</i>
			<i>Ophryoesa</i>

August	<i>Gonatodes</i>	September	<i>Plica</i>
	<i>Thecadactylus</i>	October	<i>Plica</i>
	<i>Sphaerodactylus</i>	November	<i>Anolis</i>
	<i>Anolis</i>	December	<i>Anolis</i>
	<i>Polychrus</i>		
	<i>Ophryoessa</i>		
	<i>Mabuia</i>		

Order LACERTILIA

Family GECKONIDAE

Although not especially common in the jungle yet these little vacuum-toed lizards are the first to be seen at Kartabo, for all three genera are found in the laboratory itself. The tiny *Sphaerodactylus* come commonly about our tables and creep about the glass of the windows, snatching minute insects. The most abundant species is apparently undescribed.

The larger *Thecadactylus* are nocturnal and scurry over the walls and ceiling after moths and roaches. The natives call them Gongasockas and consider them deadly not only as to bite but even to touch. A gecko larger but congeneric with the spot-shouldered *Gonatodes*, and possessing brilliant blue eyes, has proved to be new and been named *Gonatodes beebei*. In the jungle all these geckos haunt low stumps and dead logs.

Family IGUANIDAE

Twelve species represent this family, varying widely in size, coloring, habits and haunts. The commonest of all lizards are the jungle *Anolis*, confusing as to species as they are quick to the eye. They make delightful pets, soon becoming tame and leaping upon one's hand for food. In quickness and general activity they approximate birds. Those living among low growths near the leaves on the jungle floor are of various shades of brown and grey, while the *Anolis* of higher foliage are green.

Polychrus is one of the most beautiful and interesting of Kartabo lizards. It has a complete color change from brown to green, with many variations of pattern, and is adapted to its life among the mid-foliage of the jungle not only in color but in pose. It often assumes most grotesque postures with the long, slender tail draped, tendril-like, over the leaves, and one or two of its feet

sprawled in mid-air, thereby losing all semblance to a thing of life. The *Plicas* are also leaf and branch colored, but *Ophryoessa* equals *Polychrus* in perfection of adaptation to its haunts. It invariably clings lengthwise to a twig or upright dead stem, and so closely that the eye cannot distinguish between bark and saurian, while the color in both is identical. Unlike the lizards less adapted to their surroundings, *Ophryoessa* will allow one's fingers to close about it before attempting to escape, relying as much on the perfection of its protection as does a skunk or a porcupine.

Iguana is unique in being a vegetarian, and adumbrates evolution of avian flight in its leaps from tree-tops into the water of creeks.

Family TEIIDAE

Tupinambis, the Salempenta of the natives, if three times its natural size of a yard in length would be of greater danger than a full-grown crocodile. It is the nearest Kartabo suggestion of one of the fierce extinct saurians, feeding on any small mammals and birds or reptiles which it can capture and overcome, and, in addition being an omnivorous scavenger. It is a great yellow and black inmate of the jungle, living in holes and rushing about with the noise of a herd of alarmed peccaries.

Ameiva and *Cnemidophorus* are the familiars of the jungle lizards, and *Neusticurus* is found only in and about creeks through the waters of which it swims and dives skilfully. *Cophias* is a good example of a lizard with limbs so tiny that they function only when creature is moving slowly.

Family AMPHISBAENIDAE

Degeneration of the limbs is carried to an extreme in this family, which, to outward view, are serpents. Two species are found, both burrowers underground in general.

Family SCINCIDAE

Two scinks have so far been recorded, little brown, smooth-scaled, active creatures, rather rare, which produce usually four young alive at a birth, of an astonishingly large size.

Order SERPENTES

In spite of the fact that snakes are far from common, and one may tramp for miles and for days through the jungle without ever

catching a glimpse of one, I have recorded fifty-two species from the research area. These are divided into thirty-four genera and distributed along the following eight families:

Leptotyphlopidae.....	1	genus	2	species
Typhlopidae.....	1	“	1	“
Boidae.....	4	“	5	“
Ilysiidae.....	1	“	1	“
Colubridae.....	21	“	30	“
Elaphidae.....	1	“	3	“
Amblycephalidae.....	2	“	5	“
Crotalidae.....	3	“	5	“

There are eight forms of poisonous snakes, belonging to four genera. One, *Crotalus*, has been recorded only once from the quarter mile area, and a second time outside at Kalacoon, and is decidedly a stray from more open, savanna country. The noxious species range in size from the small coral snakes, *Micrurus*, to great bush masters, *Lachesis*, eight and a half feet long. The harmless species are represented on the one hand by such diminutive forms as *Atractus*, and on the other by mighty boa constrictors and anacondas, *Boa* and *Eunectes*, fifteen to twenty feet long.

In this extremity of size the snakes rank first among the orders of reptiles, as they do also in danger to man and in general brilliance of coloring. In number of individuals they come second to lizards, but again hold first place in actual number of species.

Their haunts are hardly more limited than with the lizards, the great majority being terrestrial, but with burrowing forms such as *Leptotyphlops*, *Typhlops*, *Atractus* and *Micrurus*, aquatic as *Eunectes*, or somewhat less water-loving forms such as *Helicops* and *Hydrops*, while a few snakes are adapted solely for an arboreal life, as *Oxybelis* and *Leptophis*.

No snake can be said to be abundant nor even common. Occasional is the most that can be adduced of half a dozen forms, while the records of the remainder show them to be rare or unique.

I have found only three vertebrates feeding on snakes. Two of these were snakes themselves, *Clelia* and *Erythrolamprus*, and the third an owl, *Pulsatrix*, in which case, however, both snake and bird succumbed.

Snakes include twenty-two vertebrates in their diet, two fish, eight amphibians, five reptiles, four birds and four mammals. The detailed food of twenty-three species follows:

SNAKE STOMACH CONTENTS

Earth Worms	<i>Erythrolamprus</i>
Slugs	<i>Leptognathus variegatus</i>
Spiders	<i>Xenodon</i>
Grasshoppers	<i>Xenodon</i>
Atta Soldiers	<i>Leptotyphlops</i> <i>Typhlops</i> <i>Xenodon</i>
Insects, General	<i>Tantilla</i> <i>Erythrolamprus</i> <i>Micrurus</i> <i>Xenodon</i>
Symbranchus	<i>Hydrops</i> <i>Micrurus</i>
Plagioscion	<i>Eunectes</i>
Gastrophryne microps	<i>Xenodon</i>
Leptodactylus mystacinus	<i>Liophis</i> <i>Drymobius</i> <i>Herpetodryas</i>
Leptodactylus pentadactylus	<i>Bothrops</i>
Leptodactylus caliginosus	<i>Herpetodryas</i>
Hyla rubra	<i>Herpetodryas</i>
Hyla maxima	<i>Herpetodryas</i> <i>Bothrops</i>
Bufo marinus	<i>Xenodon</i> (two species)
Bufo typhonius	<i>Xenodon</i>
Atractus trilineatus	<i>Erythrolamprus</i>
Boa constrictor	<i>Clelia</i>
Anolis	<i>Oxybelis</i>
Cnemidophorus lemniscatus	<i>Oxybelis</i>
Ameiva ameiva	<i>Clelia</i> <i>Boa</i>
Sporophila eggs	<i>Phrynonax</i>



Fig. 13.—*Corallus caninus*; a tree boa whose scales are colored green, yellow and white.
Photograph by John Tee-Van.

Snake stomach contents—continued

Domestic Chickens	<i>Epicrates</i> <i>Herpetodryas</i> <i>Xenodon</i>
<i>Pipra leucocilla</i>	<i>Bothrops</i>
<i>Nectomys</i> sp.	<i>Herpetodryas</i>
<i>Oecomys</i> sp.	<i>Lachesis</i>
<i>Proechimys cayennensis</i>	<i>Lachesis</i>
<i>Bradypus cuculliger</i>	<i>Eunectes</i>

Breeding records of oviparous snakes extend from March 27th to October 9th with no noticeable concentration about any one month or season.

As will be mentioned later, coral snake mimicry is well marked, a few specimens of *Ilysia*, *Hydrops* and *Clelia petolaria* being found in close association with a much larger number of *Micrurus marc-gravii*. The native Indians distinguish readily between the ordinary and "hot" snakes as they call the poisonous species. Occasionally a negro gets a charm which he considers an absolute safeguard and I have seen such a man handle bushmasters and fer-de-lance with almost no precautions against a bite. In a period of seven years I have had two rather narrow escapes from being bitten, but have never heard of anyone bitten anywhere in the neighboring district.

Order SERPENTES

Family LEPTOTYPHLOPIDAE

Two species of small burrowing serpents which seem confined to the interior of termite and ant nests.

Family TYPHLOPIDAE

A single species of these burrowing *Typhlops* lives in my quarter square mile of jungle, coming rarely to the surface.

Family BOIDAE

Five boas have been recorded, all of striking coloring and two reaching a large size. The green tree boa, *Corallus caninus*, is a blaze of green, yellow and white; the anaconda, *Eunectes*, the great snake of the water, is not uncommon, while the boa constrictor occupies the same position on land.

Family ILYSIDAE

The harmless, false coral snake *Ilysia* is the only representative of this family, and burrows in damp places, often in the vicinity of true coral snakes.

Family COLUBRIDAE

Like the heterogeneous avian assemblage Coraciiformes, this consists of thirty species whose diversity of habits and outward appearance are of less importance than internal structure. *Oxybelis*, long and slender, haunts the trees, while *Xenodon*, short and thick, is wholly terrestrial, flattens its head into a perfect viperine resemblance, and feeds on such noxious things as *Bufo marinus*. *Hydrops*, semi-aquatic, resembles and associates closely with *Micrurus*, and feeds on the same food, the eel *Symbranchus*. None of the colubrian snakes can be said to be common, however, in the sense that they can be found whenever searched for.

Family AMBLYCEPHALIDAE

Five small, variegated snakes of gentle disposition and conservative habits represent this family.

Family CROTALIDAE

Five really dangerous snakes complete the list of Ophidia, but all are so rare that sometimes a month of daily tramping through the jungle fails to reveal one. *Lachesis mutus*, the notorious bush-master is found always coiled in a close circle on the jungle floor. It makes no movement on being approached, but invariably one's eye is drawn toward it while still several steps away. Whether this is from a subconscious alert perception, or the unconscious detection of a delicate odor I cannot say. When this serpent is alarmed, its odor becomes unpleasantly strong and musky. The largest individual seen, which was captured alive,⁴ measured eight feet six inches in length.

The fer-de-lance, *Bothrops lanceolatus*, is much more often observed. Many small ones have been taken from the bamboo clumps around the laboratory. Of twenty-two specimens examined two were females with well-formed embryos. The arboreal green fer-de-lance *Bothrops bilineatus*, has been found only twice, the first time when one struck at my hat as I crouched under a bush.

⁴ Jungle Peace, pp. 188-195.

Class AVES

Within the quarter of a square mile of research area at Kartabo there have been observed four hundred and sixty-four species of birds. From the Colony of British Guiana as a whole there have been recorded seven hundred and sixteen species. Hence in an area one-three hundred and sixty thousandth of the whole of Guiana, I have observed about sixty-four percent of the total number of birds.

The birds of Kartabo form fifty-six percent of all the vertebrates. In number of species, and in visual, color and vocal dominance the birds stand first, yielding only to fish and amphibians in point of number of individuals, and to fish, reptiles and mammals in extremes of size. Insects are the only other organisms which stand comparison in point of general dominance.

As regards a general survey of the avifauna of Kartabo, I need add little to my chapter on the Bird Life of Bartica District (which includes Kartabo) in "*Tropical Wild Life*" pp. 91-137. The point of greatest interest in comparing the present work with this chapter is the remarkable result of intensive work in a restricted field. My notes in the earlier volume included the large collections made by professional skin collectors at Bartica, together with my notes on the whole of this region, numbering in all three hundred and fifty-one species.

As an introduction to a general survey of Kartabo birds I am reproducing from a Bulletin of the Zoological Society, an account of a Christmas bird census which will give an idea of the bird life which may be observed in the quarter mile area in a single day.

It always has been an exciting feat to see how many birds one can see within a given time or limited area. Birds of a city backyard, or a month's visitors to a bramble patch, offer a gamble which is fascinating to the human mind. I once took the greatest joy in recording seventy-six species of birds within a week, in a single tree in Brazil. This widespread human interest has been used for years with most important results by Dr. Chapman in "*Bird Lore*," whose Christmas census lists I always peruse with as much care and interest as if I had personally been a member of every party.

Mr. Inness Hartley and I once decided to make a Christmas census of the birds about our jungle laboratory at Kartabo, British Guiana, but this date occurs toward the end of the short rainy season, and their particular Christmas was a very unusual day—as

it rained from 5:00 A. M. to 5:30 P. M. The following day was almost as bad, so we had to compromise on the 27th of December, 1920.

From dawn to dark we covered considerable ground. One trip in the launch was made a short distance down the Mazaruni River, a walk was taken along the beach, two trips through the clearing about the tents and bungalow, and four trips in the jungle, all within a quarter-mile circumference. All the observations were made by Inness Hartley or myself, and we were out for about half the day—at various times from 5:30 A.M. to dark at 6:00 P. M.

On this 27th of December, 1920, the temperature was 72° at 6:00 A. M., 81° at noon, and 76° at 6:00 P. M. The morning was quiet, while the trade wind blew gently from 1:00 to 6:00 P. M. The morning was cloudy up to 11:30 A.M., while four heavy showers fell between noon and 4:00 P. M., with bright sun between them.

We observed 116 species of birds, distributed among 418 individuals. Of these a swift and a vulture may be classed as aerial; nine as water or shore birds; eighteen as inhabitants of the clearing, and the remaining eighty-seven tenants of the jungle itself. We had been studying the birds hereabouts for seven months, and yet it is so difficult to identify birds in the high trees with any certainty that we had to shoot about twenty species to be sure of them. Besides those which we identified, we each saw at least twenty or thirty more whose identity escaped both glass and gun.

Several, such as the goldbird and the giant goatsucker or poor-me-one, were identified from the call alone—this being absolutely unmistakable.

It is interesting to note that thirty-seven species or 31 per cent of the whole, were named by Linnaeus, emphasizing the interest of this region as the origin of most of the collections which he named over one hundred and fifty years ago.

<i>No. Seen</i>	<i>Common Name</i>	<i>Scientific Name</i>
Two	Guiana Great Tinamou	<i>Tinamus major major</i> (Gmel.)
Two	Variegated Tinamou	<i>Crypturus variegatus variegatus</i> (Gmel.)
One	Crested Curassow	<i>Crax nigra</i> Linné
One	Lesser Olive Guan	<i>Penelope marail</i> (P. L. S. Mull.)
Three	Little Chachalaca	<i>Ortalis motmot</i> (Linné)
One	Guiana Partridge	<i>Odontophorus guianensis guianensis</i> (Gmel.)
Two	Purple-tinted Pigeon	<i>Oenaenas purpureotincta</i> (Ridg.)

Bird census—continued

Six	Talpacoti Ground Dove	<i>Chaemepelia talpacoti</i> (Temm. & Knip.)
Three	Great-billed Tern	<i>Phaetusa chloropoda</i> (Vieill.)
Two	Common Tern	<i>Sterno hirundo</i> (Linné)
Two	Collared Plover	<i>Charadrius collaris</i> (Vieill.)
Two	Spotted Sandpiper	<i>Actitis macularia</i> (Linné)
One	Little Blue Heron	<i>Florida caerulea caerulea</i> (Linné)
Three	Yellow-headed Vulture	<i>Cathartes aura urubitinga</i> (Pelz.)
Three	Red-throated Caracara	<i>Ibycter americanus</i> (Bodd.)
One	Black-faced Hawk	<i>Leucopternis melanops</i> (Lath.)
One	Swallow-tailed Kite	<i>Elanoides forficatus yetupa</i> Bonn. & Vieill.
Four	Red-and-Yellow Macaw	<i>Ara macao</i> (Linné)
Five	Mealy Amazon	<i>Amazona farinosa farinosa</i> (Bodd.)
One	Dusky Parrot	<i>Pionus fuscus</i> (P. L. S. Mull.)
Eight	Purple Guiana Parrot	<i>Touit purpurata</i> (Gmel.)
Two	Black-headed Caique	<i>Pionites melanocephala melanocephala</i> (Linné)
Two	Great Gray Kingfisher	<i>Megaceryle torquata cyanea</i> (Vieill.)
Two	Little Green Kingfisher	<i>Chloroceryle americana americana</i> (Gmel.)
Two	Guiana Motmot	<i>Momotus momota momota</i> (Linné)
Two	Giant Goatsucker	<i>Nyctibius griseus griseus</i> (Gmel.)
One	White-necked Nighthawk	<i>Nyctidromus albicollis albicollis</i> (Gmel.)
Twenty	Swift	<i>Chaetura</i> sp.
One	Cayenne Hermit	<i>Phaethornis superciliosus superciliosus</i> (Linné)
Three	Red-vented Hermit	<i>Phaethornis ruber ruber</i> (Linné)
One	Broad-shafted Sabrewing	<i>Campylopterus largipennis</i> (Bodd.)
Two	Black-eared Fairy	<i>Heliothrix aurita aurita</i> (Gmel.)
Six	Black-throated Trogon	<i>Trogonurus curucui curucui</i> (Linné)
Three	Green Trogon	<i>Trogon strigilatus strigilatus</i> (Linné)
Three	Southern Trogon	<i>Chrysotrogon violaceus violaceus</i> (Gmel.)
Two	Black-tailed Trogon	<i>Curucujus melanurus melanurus</i> (Swainson)
Six	Common Ani	<i>Crotophaga ani</i> Linné
Two	Black-spotted Barbet	<i>Capito niger</i> (P. L. S. Mull.)
Five	Sulphur- and White-breasted Toucan	<i>Ramphastos vitellinus</i> Licht.
One	Green Aracari	<i>Pteroglossus viridis</i> (Linné)

Bird census—continued

Two	Golden Jacamar	<i>Jacamerops aurea</i> (P. L. S. Mull.)
One	Collared Puffbird	<i>Bucco capensis</i> Linné
Three	Swallow Puffbird	<i>Chelidoptera tenebrosa tenebrosa</i> (Pall)
One	Spix's Amazonian Woodpecker	<i>Celeus undata</i> (Linné)
One	Red-necked Woodpecker	<i>Scapanus rubricollis</i> (Bodd.)
Two	Lineated Woodpecker	<i>Ceophloeus lineatus lineatus</i> (Linné)
Three	Undulated Piculet	<i>Picumnus buffoni undulatus</i> Hargitt
One	Ashy-backed Bushbird	<i>Dysithamnus mentalis spodi-notus</i> Salv. & God.
Five	Mouse-colored Bushbird	<i>Hypolophus murinus</i> (Scl. & Salv.)
Eight	Cinereous Bushbird	<i>Thamnomanes glaucus</i> Cab.
Three	Pygmy Antbird	<i>Myrmotherula pygmaea</i> (Gmel.)
Five	Rufus-bellied Antbird	<i>Rhopias guttata</i> (Vieill.)
Twelve	White-flanked Antwren	<i>Myrmopagis axillaris axillaris</i> (Vieill.)
One	Gray-breasted Antbird	<i>Myrmopagis cinereiventris cinereiventris</i> (Scl. & Salv.)
Two	Spotted-tailed Antbird	<i>Herpsilochmus sticturus sticturus</i> Salvin
Three	White-bellied Antwren	<i>Rhamphocaenus albiventris albiventris</i> Sclater
Six	White-fronted Antcatcher	<i>Pithys albifrons</i> (Linné)
One	Rufus-fronted Antcatcher	<i>Anoplops rufigula rufigula</i> (Bodd.)
Five	Schomburgk's Antcreeper	<i>Myrmoborus leucophrys angustirostris</i> (Cab.)
One	Woodcock Antbird	<i>Rhopoterpe torquata torquata</i> (Bodd.)
One	Black-faced Ant-thrush	<i>Formicarius colma</i> subsp.
Two	Guiana Spinetail	<i>Synallaxis gujanensis gujanensis</i> (Gmel.)
Five	Dusky-vented Philydor	<i>Philydor erythrocercus erythrocercus</i> (Pelz.)
Two	Brown-tailed Xenops	<i>Xenops genibarbis genibarbis</i> Ill.
Three	Little Wedge-billed Woodhewer	<i>Glyphorhynchus cuneatus</i> subsp.
Two	Guiana Spotted Woodhewer	<i>Xiphorhynchus guttatus sororius</i> (Berl. & Hart.)
One	Chestnut-rumped Woodhewer	<i>Xiphorhynchus pardalotus</i> (Vieill.)
One	Rufus-throated Woodhewer	<i>Dendrexetastes rufigula</i> (Less.)
One	Guiana Curve-billed Woodhewer	<i>Campylorhampus trochilirostris procurvoides</i> (Lafr.)

Bird census—continued

One	British Guiana Flatbill	<i>Craspedoprion olivaceus guianensis</i> McConnell
Two	Pelzeln's Flatbill	<i>Rhynchocyclus sulphureus</i> subsp.
Two	Spotted Tody Flycatcher	<i>Todirostrum maculatum maculatum</i> Desmarest
One	Helmeted Pygmy Tyrant	<i>Colaptes auratus</i> (Bodd.)
Four	Oily Flycatcher	<i>Pipramophia oleaginea oleaginea</i> (Licht.)
Three	Yellow-vented Flycatcher	<i>Elaenia martinica flavogaster</i> (Thun.)
Three	Small-billed Kiskadee	<i>Myiozetetes cayanensis cayanensis</i> (Linné)
Nine	Guiana Kiskadee	<i>Pitangus sulphuratus sulphuratus</i> (Linné)
Four	Lesser Kiskadee	<i>Pitangus lictor lictor</i> (Licht.)
Two	Pitangua Flycatcher	<i>Megarhynchus pitangua</i> (Linné)
Three	Whiskered Flycatcher	<i>Myiobius barbatus barbatus</i> (Gmel.)
One	Royal Great Crest	<i>Onychorhynchus coronatus coronatus</i> (P. L. S. Mull.)
Seven	White-throated Kingbird	<i>Tyrannus melancholicus satrapa</i> (Cab. & Hein.)
Two	Golden-headed Manakin	<i>Pipra erythrocephala erythrocephala</i> (Linné)
Two	White-crowned Black Manakin	<i>Pipra leucocilla leucocilla</i> (Linné)
Three	Crackling Manakin	<i>Manacus manacus manacus</i> (Linné)
Four	Black-tailed Tityra	<i>Tityra cayana</i> (Linné)
Two	Goldbird	<i>Lathria cinerea cinerea</i> (Vieill.)
Five	Spix's Attila	<i>Attila thamnophiloides</i> Spix
Three	Cayenne Chatterer	<i>Cotinga cayana</i> (Linné)
Two	Pompadour Chatterer	<i>Xipholena punicea</i> (Pallas)
Three	Variegated Swallow	<i>Iridoprocne albiventris</i> (Bodd.)
Four	Gray-breasted Martin	<i>Progne chalybea chalybea</i> (Gmel.)
Four	White-banded Swallow	<i>Atticora fasciata</i> (Gmel.)
Three	Guiana House Wren	<i>Troglodytes musculus</i> subsp.
One	Quadrille Bird	<i>Leucolepis musica musica</i> (Bodd.)
Two	Sabian Thrush	<i>Planesticus fumigatus</i> subsp.
Three	Guiana Woodbird	<i>Pachysylvia muscipina muscipina</i> (Scl. & Salv.)
One	Yellow Warbler	<i>Dendroeca aestiva aestiva</i> (Gmel.)
Five	Chestnut-bellied Seed-eater	<i>Sporophila castaneiventris</i> Cab.
Seven	Olive Kernel-eater	<i>Pitylus canadensis canadensis</i> (Linné)

Bird census—continued

Three	Guiana Bananaquit	<i>Coereba chloropyga guianensis</i> (Cab.)
Four	Turquoise Honey Creeper	<i>Dacnis cayana cayana</i> (Linné)
Eleven	Green Honey Creeper	<i>Chlorophanes spiza spiza</i> (Linné)
One	Violaceous Euphonia	<i>Tanagra violacea violacea</i> (Linné)
Two	Chestnut-headed Tanager	<i>Tangara gyrola</i> (Linné)
Six	Yellow-bellied Tanager	<i>Tangara mexicana mexicana</i> (Linné)
Eight	Blue Tanager	<i>Thraupis episcopus episcopus</i> (Linné)
Two	Eastern Palm Tanager	<i>Thraupis palmarum melanoptera</i> (Sclater)
Eighteen	Silver-beaked Tanager	<i>Ramphocelus carbo carbo</i> (Pall.)
Two	Fulvus-crested Tanager	<i>Tachyphonus surinamus surinamus</i> (Linné)
Two	Golden-crested Tanager	<i>Tachyphonus intercedens</i> Berl.
Fifty	Great Black Cacique	<i>Ostinops decumanus decumanus</i> (Pall.)
One	Yellow-backed Cacique	<i>Cacicus cela</i> (Linné)
Two	Rice-grackle	<i>Cassidix oryzivora oryzivora</i> (Gmel.)
Three	Red-breasted Blackbird	<i>Leistes militaris militaris</i> (Linné)
One	Moriche Oriole	<i>Icterus chryscephalus</i> (Linné)

Out of the total number of Kartabo birds twenty-one are migrants from North America, while the rest are more or less permanent residents, nesting in the district or in adjacent parts of the Colony. While it would seem easy to make this distinction between migrants and residents, as a matter of fact the line is rather loosely drawn. Some, such as the barn swallow, are unmistakably transients, living here in the tropics only during the season of northern cold. But others, such as the yellow warbler, while appearing in unusually large numbers during the season of migration, are also present throughout the year. If such a species should be found breeding it could be defined as migratory only to a limited degree. The egrets, while well known as migrants or as residents in parts of the United States, are resident in British Guiana.

The North American migrants include the following:

Golden Plover	Kingbird
Semipalmated Plover	Bank Swallow
Black-necked Stilt	Barn Swallow

Greater Yellowlegs
 Lesser Yellowlegs
 Solitary Sandpiper
 Spotted Sandpiper
 Upland Plover
 Wilson's Snipe
 Belted Kingfisher
 Yellow-billed Cuckoo

Purple Martin
 Yellow Warbler
 Black-poll Warbler
 Small-billed Water-thrush
 Redstart
 Summer Tanager
 Bobolink

A vivid idea of the relative abundance of species of birds in the tropics as compared with the temperate zones is shown by the avifauna of New York State and that of the quarter of a square mile of jungle about Kartabo. The former, in actual area, is 180,000 times as large as our tropical field of research, and, according to Eaton, contains four hundred and eleven species of birds. For purposes of fair comparison it is necessary to eliminate from this list three exterminated species, six introduced species, and seventy-two accidental visitors which play no real part in the bird life of the State. This leaves three hundred and thirty New York birds as compared with four hundred and sixty-four at Kartabo. These two lists comprise twenty-four orders, of which seventeen are common to both localities, two are found only in New York, and five only at Kartabo.

The relative comparison of the orders is as follows:

The Birds of New York State and of Kartabo

	New York	Kartabo
Total Species.....	330.....	464
Migrants.....	262.....	21

Orders common to both Localities

Galliformes.....	3.....	6
Columbiformes.....	1.....	10
Ralliformes.....	8.....	10
Podicipidiformes.....	5.....	1
Lariformes.....	23.....	4
Charadriiformes.....	38.....	14
Gruiformes.....	1.....	6
Ardeiformes.....	9.....	11
Anseriformes.....	36.....	2
Pelicaniformes.....	4.....	2

Orders common to both localities—continued

Cathartiformes	1	4
Accipitriformes	17	28
Strigiformes	11	4
Coraciiformes	5	50
Cuculiformes	2	11
Piciformes	9	27
Passeriformes	148	241

Orders exclusively or dominantly Temperate

Podicipidiformes	Charadriiformes
Procellariiformes	Anseriformes
Alciformes	Strigiformes
Lariformes	

Orders exclusively or dominantly Tropical

Tinamiformes	Psittaciformes
Columbiformes	Coraciiformes
Gruiformes	Trogoniformes
Phoenicopteriformes	Cuculiformes
Cathartiformes	Scansores
Accipitriformes	Piciformes

Treating the Passeriformes from the point of view of families we find the following interesting line-up between the two localities:

Passeriformes of New York State and of Kartabo

	New York	Kartabo
Total Families	19	23
Total Species	148	241

Families common to both Localities

Tyrannidae	9	48
Hirundinidae	6	8
Muscicapidae	3	1
Troglodytidae	5	7
Mimidae	3	2
Turdidae	8	4
Vireonidae	6	7
Mniotiltidae	38	10
Motacillidae	1	1

Families common to both localities—continued

Fringillidae.....	41.....	17
Tangaridae.....	2.....	22
Icteridae.....	9.....	12
Corvidae.....	5.....	1

Families exclusively or dominantly Temperate

Alaudidae	Sittidae
Bombycillidae	Paridae
Turdidae	Mniotiltidae
Laniidae	Fringillidae
Certhiidae	Corvidae

Families exclusively or dominantly Tropical

Conopophagidae	Dendrocolaptidae
Formicariidae	Tyrannidae
Rhamphocaeidae	Pipridae
Furnariidae	Cotingidae
Synallaxidae	Coerebidae
Xenopidae	Tanagridae

In future monographs, I shall treat in detail the actual annual and semi-annual breeders.

Of the strictly resident birds, an astonishingly large number are extremely local or sedentary. For example, if I wish to hear quadrille wrens, or at least see them, I am almost certain of doing so every month in the year by going to the Hacka Palm Swamp, in the vicinity of R11; from January to December the tiny chuckle-dee flycatcherlets, *Colopteryx galeatus macconnelli*, inhabit N12; crackling manakins, *Manacus manacus manacus*, never fail me in P15; and Guiana wrens, *Thryothorus griseigula*, are ever present tenants of the region about D8.

The nesting is in many cases almost as exact, and an egg of the Who-are-you, *Nyctidromus albicollis*, is unfailing, twice a year, in J12.

Except during the breeding season, one is impressed by the social instinct of the bird life, many species keeping in pure culture flocks, such as parrakeets, caciques and toucans, or in the never-failing, peripatetic, mixed flocks of ant-birds, tree-creepers and other small fry.

The point of view I have chosen to take up here in special detail

is the interrelationship of enemy and prey, concerning the two more primitive of the trio of animal activities.

The problem of avian enemies is an example of how even years of intensive concentration in the tropics result in only a skimming of the surface. One of the most evident facts is that birds have terrific competition to contend with. Again and again I have lost eggs or young by delaying a day, or even an hour or two, in collecting them. On the second visit they will be found broken or gone altogether, and yet in my examination of hundreds of stomachs of all classes of vertebrates I have found only ten species feeding on birds, one of which had devoured the eggs alone. Five of these were snakes, four hawks and one was a mammal. Even this list should rightly be cut down to six, as three of the snakes were feeding on our domestic chickens,—although this is very certain evidence of ornithopagous habits. Unquestionably I have missed many enemies.

My evidence as to the diet of birds is more positive, as the following list shows:

CLASSIFIED FOOD OF BIRDS

Springtails	<i>Chloronherpes flavigula</i>
Earth-worms	<i>Aramides cajanea</i>
Mollusks	<i>Creciscus viridis</i> <i>Hylopezus macularia</i> <i>Synallaxis guianensis</i> <i>Myiarchus ferox</i>
Sowbugs	<i>Tachyphonus rufus</i>
Small Crustaceans	<i>Theristicus caudatus</i> (several hundred)
Shrimps	<i>Butorides striata</i> <i>Cochlearius cochlearius</i> <i>Actitis macularia</i> <i>Pitangus sulphureus</i>
Crabs	<i>Butorides striata</i> <i>Actitis macularia</i> <i>Theristicus caudatus</i> <i>Tigrisoma lineatum</i> <i>Sclateria naevia</i> <i>Pitangus sulphureus</i> <i>Aramides cajanea</i> <i>Heliornis fulica</i> <i>Cochlearius cochlearius</i>

Classified food of birds—continued

Scorpions	<i>Dromococcyx pavoninus</i> <i>Pithys albifrons</i> <i>Campylorhamphus procurvoides</i>
Millipedes	<i>Crotophaga ani</i> <i>Erionotis amazonicus</i> <i>Formicarius moniliger crissalis</i> <i>Xiphorhynchus pardalotus</i> <i>Dendrocolaptes certhia</i>
Centipedes	<i>Leucopternis melanops</i> <i>Crotophaga ani</i> <i>Erionotis amazonicus</i> <i>Formicarius colma</i> <i>Hylopezus macularia</i> <i>Cyanocorax cayana</i>
Harvestmen	<i>Crotophaga ani</i> <i>Sclateria naevia</i>
Spiders	Sixty species of birds
Mites	Two species of birds
Orthoptera (total)	Seventy-eight species of birds
Grasshoppers	Forty-six species of birds
Roaches	Twenty-seven species of birds
Crickets	Five species of birds
Rhipipteryx	<i>Myrmoborus angustirostris</i>
Mole Crickets	<i>Butorides striata</i> <i>Crotophaga major</i>
Mantids	Eight species of birds
Neuroptera (total)	Five species of birds
Mantispid	<i>Dendrocincla fuliginosa</i>
Diptera	Twenty-one species of birds
Termites	<i>Ibycter americanus</i> <i>Chloronerpes flavigula</i> <i>Celeus hellmayri</i> <i>Picumnus buffoni undulatus</i> <i>Myrmopagis axillaris</i> <i>Myrmoderas ferruginea</i> <i>Hypocnemis cantator</i> <i>Myrmoborus angustirostris</i>

Classified food of birds—continued

	<i>Formicarius colma</i>
	<i>Hylopezus macularia</i>
	<i>Glyphorhynchus cuneatus</i>
	<i>Placostomus gumia</i>
	<i>Pipromorpha oleaginea</i>
	<i>Muscivora tyrannus</i>
	<i>Atticora fasciata</i>
	<i>Elaenea cristata whitelyi</i>
Hemiptera (total)	Forty-one species of birds
Cicadas	Ten species of birds
Reduviid	One species
Dragonflies	<i>Pitangus lictor</i> <i>Tachycineta albiventris</i> <i>Progne chalybea</i>
Damselfly	<i>Notharcus tectus</i>
Lepidoptera (total)	Thirty-six species (no butterflies)
Moths	<i>Falco ruficularis</i> <i>Lurocalis semitorquatus</i> <i>Jacamerops aurea</i> <i>Thamnophilus incertus</i> <i>Myiodynastes maculatus</i> <i>Progne chalybea</i> <i>Scotothorus olivaceus</i>
Lepidopterous Pupae	<i>Corythopsis torquata anthoides</i>
Butterfly Eggs	<i>Myrmoderus ferruginea</i>
Caterpillars	Twenty-nine species of birds
Beetles	One hundred and forty species of birds
Cetonids and Metallic Beetles	Twenty-two species
Weevils	Forty-two species
Water Beetles	<i>Butorides striata</i>
Hymenoptera (total)	Ninety-five species of birds
Hymenoptera (general)	Twenty-three species
Wasps	Twelve species of birds
Bees	Eight species of birds
Ants	Fifty-eight species of birds

Classified food of birds—continued

Leaf-Cutting Ants (<i>Atta</i>)	<i>Myiarchus ferox</i>
Fish	<i>Ardea cocoi</i> <i>Phaetusa chloropoda</i> <i>Sterna superciliosa</i> <i>Cochlearius cochlearius</i> <i>Pitangus sulphureus</i> <i>Phalacrocorax nigrea</i> <i>Anhinga anhinga</i> <i>Chloroceryle inda</i>
<i>Bufo marinus</i>	<i>Urubitinga urubitinga</i>
<i>Bufo guttatus</i>	<i>Urubitinga urubitinga</i>
Unidentified Lizards	<i>Micrastur interstes</i> <i>Attila spadiceus spodiostethus</i> <i>Attila thamnophiloides</i> <i>Attila uropygialis</i>
<i>Anolis</i>	<i>Harpagus bidentatus</i>
<i>Cnemidophorus</i>	<i>Leucopternis melanops</i> <i>Hylopezus macularia</i>
<i>Ameiva</i>	<i>Leucopternis melanops</i> <i>Gampsonyx swainsoni</i>
<i>Polychrus</i>	<i>Elanoides furcatus</i>
Snake	<i>Pulsatrix perspicillata</i>
Rail	<i>Harpia harpyia</i>
Tanager (nestling)	<i>Elanoides forficatus yetupa</i>
<i>Tangara violacea</i>	<i>Falco rufigularis</i>
<i>Chlorophanes spiza</i>	<i>Falco albigularis</i>
<i>Cyanerpes cyaneus</i>	<i>Elanoides forficatus yetupa</i> (egg only) <i>Falco albigularis</i>
Unidentified Birds	<i>Asturina nitida</i> <i>Falco rufigularis</i>
Mouse	<i>Rupornis magnirostris</i> <i>Chondrohierax palliatus</i> <i>Ciccaba superciliaris macconnelli</i>
Bat	<i>Ciccaba huhula</i>
Monkey	<i>Thrasaetus harpyia</i> <i>Spizaetus tyrannus</i>
Three-toed Sloth	<i>Harpia harpyia</i>

In the quarter square mile of jungle under observation I have breeding records of two hundred and five species of birds, scattered throughout seven hundred and three separate records of eggs, young or breeding condition.

To the following list of the species I have added the months in each case and the number of times in which breeding has been observed in each month. I have followed Chubb in his "Birds of British Guiana" as to sequence and scientific names:

BREEDING RECORD OF KARTABO BIRDS

Tinamus major—March (7), April (17), May (7).

Crypturus soui—May (2).

Crypturus variegatus—March (3), April (5), May (3), June (4), July (3), September, October.

Crax nigra—March, April (3), August.

Penelope marail—July.

Penelope granti—March, April (2).

Ortalis motmot—May, August.

Odontophorus guianensis—April (2), May (3), June (2), August (2), September.

Columba speciosa—April (4), May.

Columba purpureotincta—May.

Chaemepelia griseola—August.

Chaemepelia talpacoti—March (3), April, September (3), November, December.

Leptoptila rufaxilla—March (2), April (5), May (5), September.

Leptoptila verreauxi—September.

Oreopelia montana—March, April (5), May (5), June (3).

Aramides cajanea cajanea—June.

Porzana albicollis—April to mid-July, fresh eggs.

Creciscus exilis—April, September.

Creciscus viridis—April 5–July 13, fresh eggs; June.

Phaethusa chloropoda—August, 3 month juv.

Jacana spinosa—January, June.

Eurypyga helias—April, May, June (2).

Psophia crepitans—March, April, August.

Theristicus caudatus—June.

Butorides striata—August.

Anhinga anhinga—June.

Ibycter ater—March.

Milvago chimachima—March, May.

Micrastur gilvicollis—April.

Leucopternis melanops—March.

Elanoides forficatus—March.

Chondrohierax palliatus—May.

Breeding record of birds—continued

- Ictinia plumbea*—March, April, August.
Ciccaba superciliaris—April.
Amazona dufresniana—March.
Pionus menstruus—June.
Pionus fuscus—March.
Pionites melanocephala—June.
Chloroceryle amazona—July.
Chloroceryle inda—May.
Chloroceryle a. aenea—July.
Momotus m. momota—April (2), May.
Nyctibius griseus—April, September (2).
Hydropsalis schomburghki—May.
Nyctidromus albicollis—March, April (3), May, August, September (4).
Caprimulgus nigrescens—March (2), April (5), May, June, July (2), September (4).
Chaetura brachyura—March.
Cypseloides fumigatus—June.
Phaethornis superciliosus—May, August, September, November.
Phaethornis ruber—March (2), September, October.
Campylopterus largipennis—May, September.
Thalurania furcata fissilis—March, April, May (2), July (2).
Anthrocothorax violicauda—May (3), July, August.
Polytmus chrysobranchus—May (2).
Topaza pella—March, April, May, July (4), August (3), September.
Heliothrix aurita—July.
Trogonurus collaris—April, May (2).
Trogon melanurus—May.
Trogon rufus—April.
Trogon s. strigilatus—March, April, June.
Trogon violaceus—May.
Piaya cayana—April, July, August, September.
Neomorphus rufipennis—June.
Dromococcyx pavoninus—May, June.
Crotophaga ani—February (2), March, April (2), June, September (3).
Capito niger—April.
Ramphastus monilis—March.
Ramphastus vitellinus—March, April, May.
Pteroglossus aracari—April (2), August.
Pteroglossus viridis—March.
Urogalba d. dea—September.
Galbula albirostris—May, August, September.
Bucco capensis—April, August.
Bucco macrorhynchus—May.
Monasa niger—July (2).
Chelidoptera tenebrosa—April (2), September.
Melanerpes rubrifrons—March, April.
Campephilus rubricollis—March, July.

Breeding record of birds—continued

Campephilus melanoleucus—March.

Picumnus undulatus—May.

Corythopsis torquata anthoides—April, May (2), June.

Cymbilaimus lineatus—May, July.

Frederickena viridis—September.

Erionotis tristis—May.

Dysithamnus murinus—March (2), April, May (2), June, October.

Dysithamnus saturninus—April.

Thamnomanes glaucus—March (2), May.

Myrmopagis axillaris—April (3), June.

Poliolaema cinereiventris—April, June.

Poliolaema guttata—May, September.

Herpsilochmus sticturus—May.

Terenura spodioptila—May, June, August.

Rhamphocaenus albiventris—March, April, May, August, September (3).

Cercomacra tyrannina saturator—November.

Manikup albifrons—March, April (2), May (2), June, September.

Anoplops rufigula—June, August.

Myrmornis torquata—August.

Sclateria naevia—June.

Sclateria leucostigma—May.

Myrmoderas ferrugineus—January, June.

Hypocnemis cantator—May, April, September.

Myrmoborus angustirostris—May, June.

Dichropogon poecilonota—July.

Stictomyrmornis naevius—March.

Formicarius colma—April, June.

Formicarius crissalis—May.

Grallaria brevicauda—April.

Hylopezus macularia macconnelli—April, May, June (4), July (3).

Sclerurus caudacutus—May.

Synallaxis guianensis—February, March, May, June, July (2).

Synallaxis cinnamomea—February, March.

Automolus turdinus macconnelli—March (2), June, August.

Automolus cervicalis—March, May.

Glyphorhynchus cuneatus simillimus—June (4), July (3), August, October, November (2).

Dendrocincla fuliginosa—April.

Xiphorhynchus sororius—March.

Campylorhampus procurvoides—March.

Dendrocolaptes plagosus—March, April, May.

Fluvicola pica—February, June.

Arundinicola leucocephala—April.

Placostomus griseiceps—May.

Placostomus saturatus—June, August.

Breeding record of birds—continued

- Rhynchocylus sulphureus examinatus*—May, June.
Rhynchocylus poliocephalus inquistor—September.
Todirostrum cinereum—February (3), May, June.
Todirostrum maculatum—March, June, September.
Perisotriccus ecaudatus miserabilis—May, September.
Colopteryx galeatus macconnelli—May (2).
Pipromorpha oleaginea macconnelli—March (2), April (3), May.
Ornithion pusillum—March (2).
Tyranniscus acer—April.
Elaenia pagana macconnelli—May, June, September.
Elainopsis guianensis—May, July.
Legatus albicollis—March, May.
Myiozetetes cayennensis—February, March, April, May, July.
Pitangus sulphuratus—January, February (2), March (3), April, May.
Pitangus lictor—February (2), March (2), May (2), September.
Megarhynchus pitangua—March.
Myiobius barbatulus—March, May (3), June, July (2), October.
Myiarchus ferox—February.
Empidonomus varius parvirostris—May.
Tyrannus satrapa—March (4), April (5), May (4), September (2).
Muscivora tyrannus—March.
Pipra aureola—March.
Pipra erythrocephala—February, March, April, June.
Pipra leucocilla—March (2), May (3), July, December.
Pipra suavisissima—March, April, May.
Piprites chlorion—May.
Corapipo gutturalis—March, May.
Chiromachearis manacus—March (3), July.
Scotothorus olivaceus—December.
Tityra cayana—March (2).
Lathria cinerea—March (2).
Laniocera hypophyrha—May.
Lipangus simplex—September.
Attila spadiceus spodiostethus—March, May.
Phoenicocercus carnifex—January.
Cotinga cayana—September.
Xipholena punicea—March, June.
Querula purpurata—April (2).
Calvifrons calvus—June, September.
Tachycineta albiventris—April, September.
Progne chalybea—March (3), May (3), June, September.
Pheugopedius griseigula—May, June (2), October.
Troglodytes clarus—February, May.
Leucolepis arada—April, June (2), July.
Microcerculus bambla—May.
Planesticus fredericki—May (2), June.

*Breeding record of birds—continued**Planesticus albiventer*—April.*Planesticus phaeopygus*—April (2), May (4), June.*Pachysylvia muscicapina*—November.*Cyanocompsa rothschildi*—January.*Oryzoborus brevirostris*—March (2), June.*Sporophila bouvronides*—May.*Sporophila lineola*—April, June.*Sporophila gutturalis roraimae*—March, May, June.*Microphila castaneiventris*—March (4), April, June, July, September, November.*Microphila minuta*—May.*Volatinia splendens*—July.*Pitylus grossus*—July.*Caryothraustes canadensis*—March, November.*Coccopsis gularis*—April, June, October.*Arremon taciturnus*—March, April (2), May (4), June.*Coereba guianensis*—March, September (2).*Dacnis cayana*—September.*Cyanerpes cyaneus*—May (2), June (3), July (2).*Cyanerpes caeruleus*—May (2).*Tanagra cayennensis*—June.*Tanagra violacea*—March, April, May, September.*Tanagrella velia*—December.*Tangara gyrola*—June, August.*Tangara mexicana*—April, May, September, December.*Thraupis episcopus*—March (3), April (2), May (2), June, September, October.*Thraupis melanopectera*—February, April (4), May (2).*Ramphocoelus carbo*—March (5), April (4), May (5), August, October.*Lanio fulvus*—April, May, June (2).*Tachyphonus rufus*—March (3), April (2), May (2).*Ostinops decumanus*—April (2).*Cacicus cela*—March (3), April, September.*Cassidix oryzivora*—March (3), April (2).*Leistes militaris*—April, May, June, September, October.*Icterus xanthornus*—February, June.*Melanopsar chrysocephalus*—February (2), March (2), July.*Cyanocorax cayanus*—March, April, May (3), June.

We thus have the following interesting distribution of breeding records through the twelve months; beginning with February as that is the first month of the Short Dry Season:

February	20	May	154
March	127	June	84
April	142	July	49

August	30	November	8
September	59	December	6
October	10	January	4

As shown in the accompanying chart, the climax of the breeding season is suddenly approximated in March, reaching its extreme in May, then descending rather abruptly and evenly to a low mark in August. September shows a second node of activity, indicating the second nesting season for a number of species which have already bred in March. The descent from September is abrupt and an exceedingly low mark at once reached, which descends even lower in the following three months, becoming almost nil in January.

THE ORDERS OF KARTABO BIRDS

Twenty-two orders of birds are represented in the research area, leaving three Guiana orders absent; these latter being hoatzins, petrels and horned screamers.

The following is a list of the orders, with the numbers of their respective species:

Order TINAMIFORMES

Family TINAMIDAE

Four species of these solitary birds are recorded, two common, one rare and one unique. All are medium-sized, brownish birds, feeding, nesting, and, with one exception, roosting on the jungle floor. A *Tinamus* and a *Crypturus* are among our chief sources of food, and I have records of one hundred and seventy-six shot either by ourselves or our Indian hunters. These were taken in or just outside of the Kartabo area, and yet the birds are as plentiful as they ever were. The remarkable life-history and breeding habits of the birds I am making the subject of a monograph which will follow this ecological paper. The birds are very protectively colored, as are the single eggs of *Crypturus*, but those of *Tinamus* contrast strongly with the dead leaves. The voice of *Tinamus* is a loud, penetrating, sweet whistle, a very characteristic jungle sound in the evening and on moonlit nights.

Order GALLIFORMES

Family CRACIDAE

Four species of jungle "turkeys" live within the quarter mile, none of them really common nor yet rare. Although pheasant-like

in superficial appearance, they are quite arboreal. The *Crax* and the two *Penelopes* are often shot for food. *Ortalis motmot* is wholly unlike all the other Galliformes in frequenting the haunts of man, coming close to the edge of our clearing at daybreak and calling in loud duets for many minutes. Flocks of the *Penelopes* in the jungle give utterance in the early morning to the most astonishing outcry of any creature I have ever heard. We have shot about sixty each of *Crax* and *Penelope* without diminishing their numbers.

Family ODONTOPHORIDAE

Two small leaf-colored partridges live on the jungle floor, one rarely seen, the other occasionally. They lay four white eggs, associate in small flocks, the voice is not loud, and their food consists chiefly of roaches and beetles. The Indians have brought in about twenty-five.

Order COLUMBIFORMES

Family COLUMBIDAE

Ten doves and pigeons range in size from the big *Lepidoenas speciosa* to the tiny ground doves *Chamaepelia*. The latter are found only in the clearings, and are very rare at Kartabo, not having yet established themselves. The larger jungle doves are solitary, with loud, booming voices heard as often at mid-day as in late afternoon. Many of them nest low down, from two to six feet from the ground.

Order RALLIFORMES

Family RALLIDAE

Nine species include such a diversity of forms as *Aramides*, *Porzana*, *Creciscus* and *Ionornis*. Only two *Creciscus* are other than rare, nesting in the coarse grass of clearings. Beetles, ants, small mollusks, earth-worms and crabs form their food.

Family HELIORNITHIDAE

The strange fin-foot, *Helionis*, is occasionally seen and taken in the jungle creeks and among the mangroves. I have never found anything but spiders and crabs in its stomach. In general appearance and haunts this takes the place of grebes, which are exceedingly rare at Kartabo.

Order PODICIPIDIFORMES

Family PODICIPIDAE

Twice I have seen pied-billed grebes near the mouths of jungle creeks.

Order LARIFORMES

Family LARIDAE

Three terns and a skimmer comprise this family, *Phaetusa* being common, the others rare. I have seen two species of terns, besides feeding on fish, sharing a flight of termites with swifts, martins and flycatchers.

Order CHARADRIIFORMES

Family CHARADRIIDAE

The wading birds include four plovers, a curlew, a stilt, two yellow-shanks, two sandpipers, and three snipe, nine of which are migrants. The commonest of these is *Actitis*, healthy individuals of which are found every month in the year.

Family JACANIDAE

The jacana is very rare at Kartabo, this, together with ground doves and red-breasted starlings, being occasional strays from the Penal Settlement, three miles down river.

Order GRUIFORMES

Family ARAMIDAE

The limpkin is a rare bird at Kartabo, being much more common on the coast.

Family EURYPYGIDAE

The sun bittern is occasional, and rarely nests among the mangroves, depositing its single large egg on a depression on some horizontal limb. Only during its courtship is it other than a silent, inconspicuous bird. Like *Psophia*, it makes an ideal pet, quickly becoming tame and remaining close to the house.

Family PSOPHIDAE

The long-legged, hump-backed trumpeter, strange as to appearance and actions, and of unknown breeding habits, is almost common, being found in good-sized flocks in the jungle, and at the

first alarm flying well up into the high trees. Its strange, ventriloquial voice is only occasionally heard, and its food consists almost wholly of beetles and ants. We have had over fifty brought in for the table, and are seldom without a tame "Warracabra" walking about the compound.



Fig. 14. Young trumpeter, *Psophia crepitans* Linné.
Photograph by Paul G. Howes.

Family IBIDIDAE

Two ibises occur, one, *Theristicus*, a very rare straggler from the inland savannas, and *Harpiprion*, a fairly common feeder along shore. Their food is tiny crustaceans, crabs and worms.

Family CICONIIDAE

A March record of four wood ibises, *Mycteria*, flying slowly over the laboratory is the only occurrence of these birds.

Order ARDEIFORMES

Family ARDEIDAE

Eleven herons have been seen, some, as *Ardea cocoi*, *Cochlearius* and *Tigrisoma* not rare, others as the egret, *Casmerodius*, appearing only as a few stray young birds after the breeding season. Crabs and shrimps form much more of their food than fish, although I have found two puffers, *Colomesus*, in the stomach of a cocoi heron.

Order PHOENICOPTERIFORMES

Family PHOENICOPTERIDAE

Three flamingoes flying low overhead is the only record for Kartabo.

Order ANSERIFORMES

Family ANATIDAE

Kartabo is both too low down-river and too far above the coast to have many ducks. The splendid Muscovy duck, *Cairina*, is rarely observed, and *Dendrocygna* now and then perch among the mangroves.

Order PELICANIFORMES

Family PHALACROCORACIDAE

The little river cormorants are occasional, appearing now and then, perching on rocks out in the river and feeding on the armored catfish which crawl out over the mud-flats.

Family ANHINGIDAE

The identical words apply to the cosmopolitan snakebird, except that its food consists solely of small fish.

Order CATHARTIFORMES

Family CATHARTIDAE

Four vultures visit Kartabo. The black *Coragyps*, which is the most abundant on the coast, is unique here, a single individual having been seen. Offal will at once attract many yellow-headed vultures, and more rarely a red-head or a white king vulture.

Order ACCIPITRIFORMES

Family FALCONIDAE

Twenty-eight hawks and eagles form a splendid section of the Kartabo avifauna. *Leucopternis*, *Ictinia* and *Elanoides* are the commonest forms, but occur only in pairs or in families of three. A number do their hunting beneath the roof of the jungle, and often can be flushed from their prey on the ground.

Ibycter is a degenerate falcon which has taken to a vegetable diet and to utterances which outdo the macaws. The giants *Morphnus*, *Spizaetus* and *Thrasaëtus* are so rare that their occurrence is an event. All examined have been feeding on monkeys.

Except for the above-mentioned *Ibycter* and the low-soaring *Elanoides*, accipiters are not conspicuous and are never gregarious.

One more exception is *Pandion*. A fish-hawk is usually to be seen perched on a beacon off-shore, and often catches fish close to our stelling.

Order STRIGIFORMES

Family STRIGIDAE

Four owls occur, of which *Pulsatrix*, the spectacled, is far most often seen or heard. It kills snakes and birds, while *Ciccaba* prefers mice. The voice of any owl is a rare sound in the tropical jungle.

Order PSITTACIFORMES

Family PSITTACIDAE

- The macaws, parrots and parrakeets number seventeen, of which six or eight are fairly common. *Ara* in pairs, *Amazona* in small, and *Touit* in large flocks, and all with loud discordant cries, are characteristic features of every-day life in the jungle. No matter how brilliant their coloring, the birds vanish when perching quietly among the lights and shadows of the foliage. All the nests found have been in hollow trees. Every one without exception is a vegetarian.

Order CORACIIFORMES

This hodge-podge comprises five diverse families,—kingfishers, motmots, goatsuckers, swifts and hummingbirds.

Family ALCEDINIDAE

Five autochthonous kingfishers and one migrant are found at Kartabo. Two specimens of our northern belted kingfisher have been secured, apparently southern stragglers. The other native species are about equally common, the larger *Megaceryle* haunting the open river, and the tiny *Chloroceryle* usually preferring the jungle creeks. All nest in the clay banks. Their notes are frequently heard and are proportionate to their size,—the big kingfisher springing a terrific rattle, and the small one uttering a sharp, high clicking.

Family MOMOTIDAE

The Guiana motmot sits in pairs in the jungle, attracting the ear by its basso-profundo notes, and the eye by its pendulum-jerking tail. It is almost common, but local, and feeds almost exclusively on coleoptera.

Family CAPRIMULGIDAE

Nine goatsuckers are found at Kartabo, three abundant vocally, and two in actual numbers. *Nyctidromus albicollis* and *Caprimulgus nigrescens* call about the laboratory every evening and morning throughout their bi-annual breeding seasons. From deep in the jungle there is heard the weird call of *Nyctibius*, the poor-me-one. This giant species is usually found up the creeks, where it deposits its egg on the top of rotten stumps. The two former lay their single egg in the bushy clearings near the laboratory at intervals of six months. Beetles and small moths form the principal food of goatsuckers hereabouts.

Family MICROPODIDAE

Eight swifts have been shot soaring over Kartabo, the commonest *Chaetura spinicauda*. The palm swift, *Reinarda*, and the feather-toed swift *Panyptila*, are decidedly rare, but occur every year, feeding high or low, according to the elevation of volant insect life.

Family TROCHILIDAE

Twenty-six hummingbirds have been taken out of the forty recorded from Guiana. Probably at least a dozen more remain

to be detected. Ten species are common, and the nests of five of them may be counted on along the vegetation of the river banks. I have obtained scores from one flowering tree, and individuals often have a very regular route, visiting the same spike of flowers or bushy inflorescence morning after morning at the same minute. Their courtship is exceedingly elaborate, and their voices, when raised in anger between battling males, are astonishingly loud.

Order TROGONES

Family TROGONIDAE

Five species of beautiful trogons occur, one of which is unique, and two others common. Their notes are loud and monotonous, they lay their eggs in termite nests, and are tame, stupid, very wonderfully colored birds. Beetles are easily first in their regimen, but they also take spiders, caterpillars, ants, grasshoppers, and cicadas in numbers.

Order CUCULIFORMES

Family CUCULIDAE

Eleven interesting birds form this assemblage, including the big rufous cuckoo, *Piaya*, the road-runner-like *Neomorphus*, the sedentary wife-sick, *Tapera*, and the two inimitable anis or old witch birds, *Crotophaga*. The latter are by far the most common, but all are far from rare. Much remains to be worked out in regard to the nesting habits of these cuckoos. *Tapera* and *Crotophaga* are inhabitants of clearings, while the rest are more jungle birds. The voices of these two are the only ones which are insistent enough to produce a deep impression on the memory. Insects of every conceivable group are eaten, but *Crotophaga* specializes in harvestmen, centipedes, squash bugs, millipedes, scorpions and other seemingly unpleasant items.

Order SCANSORES

Family CAPITONIDAE

One barbet represents its family, a brightly variegated bird, rather common in mid-jungle, often found with flocks of antbirds and warblers. Small berries form its food.

Family RAMPHASTIDAE

Five toucans live in the research area, three of which I have found breeding. Two are rare, three common. They haunt the tree-tops, and are often found in large flocks except during the breeding season. *Ramphastus vitellinus* is abundant, and their yelping voices are among the commonest of jungle sounds, and carry a mile or more.

Order PICIFORMES

Family GALBULIDAE

Five gorgeously colored jacamars live in the deep jungle, silently fly-catching from favorite perches. *Psilopornis albirostris*, the commonest species, breeds in termite nests.

Family BUCCONIDAE

Of this varied and interesting tropical family there are seven species at Kartabo. Three are fairly common, all jungle birds except *Chelidoptera*, which haunts clearings. The nests are made in stubs (*Bucco*), in holes in the jungle floor (*Monasa*), or in open, sandy soil (*Chelidoptera*). As a rule they are solitary, or found in pairs, usually silent, but with possibilities of extraordinarily varied notes.

Family PICIDAE

Fourteen woodpeckers hammer the trees in the research area, the great *Campephilus* sending a basso-profundo roll for a mile through the jungle, while the tiny *Picumnus* taps almost inaudibly. Several are constantly associated with flocks of antbirds and wood-hewers, two or three are found exclusively in and about the dead trees bordering old Indian clearings. They are all solitary, keep well up and in deep jungle are almost tree-top birds. As elsewhere, their voices are unmistakable, loud and penetrating.

Order PASSERIFORMES

This great group includes twenty-three families and two hundred and forty species, more than fifty percent of the whole Kartabo avifauna. They may be divided roughly into two divisions, first, twelve families, two of which are typically tropical, and the other ten absolutely so, and a second division of eleven families, most of which are as well or better developed in the temperate regions. In the first division there are one hundred and sixty-eight species, in

the second sixty-five. If we except Coerebidae and Tanagridae, the two divisions are aligned systematically as well as geographically—the remaining ten tropical families being also the first ten in a linear succession of Passeriform families.

There are ten species of migrants from the United States. All the remainder are residents within or at least just without the research area.

Family CONOPOPHAGIDAE

A single species, *Corythopsis*, represents this small family in the quarter square mile of research area. It is found in deep jungle, where it *walks* about on the leaves, and nests rather commonly in the same situation. It feeds on beetles, spiders and caterpillars. It is a solitary bird and a silent one. Its coloring, like that of *Arremon taciturnus*, is that of a bird only recently adapted to life in the dimness of primitive jungles.

Family FORMICARIIDAE

Thirty-nine species of antbirds occur at Kartabo, out of the fifty-one which have been recorded from British Guiana. They are by far the commonest birds of the jungle and one can seldom walk more than a few yards before hearing some one of their characteristic call-notes.

All are strong, sturdy birds of more or less sombre coloring and in their variety of general structure and activity they show very remarkable radial adaptation, paralleling many diverse groups of temperate woods, such as flycatchers, shrikes, vireos, warblers, wrens, titmice, nuthatches and thrushes, while some genera strikingly resemble such oriental forms as pittas.

When not nesting on the ground or in low bushes, they are often found in flocks with other birds of their family as well as woodpeckers, woodhewers, tanagers and others. These flocks move slowly through the jungle, each species feeding in its particular manner. The name antbird is derived from a favorite habit of many of attending the battle-front fan of army ants, benefiting by the hosts of insects which rise in vain attempts to escape. *Manikup albifrons* is the antbird *par excellence*, and its loud chirp is almost always an indication of the exact location of one of the army ants' fans of activity.

Family RHAMPHOCAENIDAE

The syrinx of this long-tailed, gnat-catcher-like antbird *Rhamphocaenus*, first led me to suspect its isolated character and when once my attention was focussed, I soon realized that it was out of place in *Formicariidae*. Mr. de W. Miller independently came to the same conclusion. It flocks with the smaller antbirds and is far from rare, being as tame as are most unusually small, delicate birds.

Family FURNARIIDAE

Two of the strange oven-birds, *Sclerurus*, live at Kartabo, one not uncommon and occasionally breeding.

Family SYNALLAXIDAE

One of the most interesting families of Kartabo birds. In habits they are as diverse as cuckoos, and in structure very remarkable readaptations for a normal perching life, while some of them still retain the stiffened rectrices, and all are still garbed in the pattern and colors, of their woodhewer-like ancestor.

Two species of *Synallaxis* haunt the clearing, build huge nests of sticks and thorns, and call to one another with loud, varied notes. Their stiffened tails are used only in a wren-like fashion. Two *Automolus* and a *Philydor* live in the deep jungle, nesting in tunnels bored in earthen banks,—silent, furtive birds.

Family XENOPIDAE

The single species of *Xenops* composing this family is another aberrant woodhewer, specializing in the direction of nuthatches. It never uses its tail as a prop, but creeps about twigs and branches. The resemblance is also striking both in regard to the shape of the beak and the general pattern of the plumage. It is a common bird, and is usually found in the flocks of antbirds.

Family DENDROCOLAPTIDAE

These thirteen sturdy birds fill the place of woodpeckers in the mid-jungle. All nest in hollows, either in the tops of stumps, in narrow folds of tree buttresses, or in termite nests. They flock with other birds, the smaller with antbirds and the larger with jays and toucans. *Glyphorhynchus* is abundant and eight other species common. Their voices are loud and one of the most memorably characteristic jungle sounds, either loud, startling and woodpecker-like, or sweet, dropping cadenzas.

All climb up tree-trunks, using their stiffened rectrices, and all have a general similarity of livery,—rufous red backs, wings and tails, and pale striped heads, necks and underparts.

Although uniform in general activities, and method of progression, yet the diversity in the actual procuring of food is reflected in the remarkable variety of beaks, some short and wedge-shaped, others resembling awls, forceps, needles, and, as an extreme, very long, slender, sickle beaks, curving far round, recalling the female huia bird of New Zealand, or certain hummingbirds.

Family TYRANNIDAE

The dominant family of Passeriformes in Guiana, and, at least in number of species, at Kartabo. In the research area, forty-eight occur, compared with sixty-nine in the whole Colony. We may make a very rough division of the thirty-five genera into a smaller number which inhabit the clearings and open spaces, typified by *Fluvicola*, *Pitangus*, *Tyrannus*, and *Muscivora*, a still smaller group which haunt the tree-tops, glades, or at least keep to sunny places, such as the marvellous *Onychorhynchus coronatus*. All of these and the others of these two groups have touches or patches of brilliant color, but the majority of deep jungle Tyrannidae, like our wood pewees, are clad in sombre greens and browns. Among many of these are *Myobius*, and the many flat-bills and midget flycatchers.

As the food list shows, many flycatchers are almost wholly vegetarians, while some are experimenting in new organic fields, such as the kiskadee, *Pitangus*, which has developed very general piscivorous habits.

The voice of these birds is, as a rule, loud and persistent, with strong carrying power. Those of the clearings have a much greater assortment of tones than the jungle species.

Family PIPRIDAE

Eleven of these little jungle birds live here. The females are sombre green and sit on their two eggs in tiny cup nests only a few feet from the ground. Their mates in varied liveries of black, white, orange, and even mother-of-pearl, fly about the mid-jungle and utter strange calls, some even cracking their wing feathers. Five are common, most of the others occasional.

Family COTINGIDAE

Twenty spectacular species are found in the Kartabo jungle, each remarkable for voice or color or habit. *Tityra* and *Attila* are clearing birds nesting in hollow trees. The latter is the brain-fever bird of this region, its never-ending call of three or five notes persisting through the heat for many hours on end. *Lathria* inhabits the deepest swamps, where it whips out tones which carry over a mile. The calf-like call of *Calvifrons*, the gorgeous coloring of *Xipholena* and *Cotinga*, culminate in the pure white plumage, the fleshy tentacles and the marvellous notes of *Vavasouria*, the bellbird.

Almost all live in families, in the tops of the tallest trees, are probably more common than I ever know, and yield their nesting secrets only to the most persistent searching. One exception to this last was a female *Xipholena* who nested in a bamboo overhanging the laboratory.

Family HIRUNDINIDAE

Swallows are abundant along the rivers but almost never enter the deep jungle. Eight species occur, two of which are migrants. The Guiana martin, *Progne chalybea*, and the variegated swallow, *Iridoprocne*, are abundant, and ready to use any box which is put up on a pole over the water. *Atticora* is one of the most beautiful, common on jungle creeks, nesting in holes in the banks.

Family MUSCICAPIDAE

A single, rare gnat-catcher represents this family.

Family TROGLODYTIDAE

Seven wrens live in these tropics, one a species of Troglodytes, as friendly to man as elsewhere, the others living in deep jungle. All are characteristic as to tails, actions and bubbling music, while the quadrille bird, *Leucolepis*, is one of the most wonderful songsters of the jungle,—singing an ever-varied flute-like theme which is among the sweetest of all bird voices. Decidedly family birds, found in pairs, threes or fours.

Family MIMIDAE

This northern family has only two representatives, a *Mimus* and a *Donacobius*, the latter a bird of the coastal savannas which is only a straggler at Kartabo. Its amazing antics and remarkable duets make it an interesting type.

Family TURDIDAE

Four thrushes are found, one of them a migrant from the United States. At evening a very wide-spread jungle song is the surprisingly robin-like call of one of these species of *Turdus*. They live in isolated pairs in fairly deep jungle, and seem to remain in almost exactly the same locality throughout the year. The nests are placed on low mossy stumps.

Family VIREONIDAE

Seven vireos of three genera, *Vireo*, *Pachysylvia* and *Vireolanus* occur, all with actions and voices typical of their family.

Family MNIOTILTIDAE

Ten wood warblers, of which four are migrants. Many individuals of the yellow warbler *Dendroica*, however, are found throughout the year. *Granatellus* has been found only twice, and is rare everywhere.

Family MOTACILLIDAE

This decidedly northern family is represented by only a single, rare pipit.

Family FRINGILLIDAE

Of this rather more typically temperate family, seventeen species are found here. About half are clearing birds, the little *Oryzoborus* and *Sporophila* being abundant, most of them singing sweet, untropical songs. The three brightly-colored grosbeaks *Pitylus*, *Periporphyrus* and *Caryothraustes* are wholly jungle birds, almost always found with the antbird flocks.

Arremon is a solitary, silent, terrestrial jungle sparrow, too brightly colored to have been there many generations. It nests on the ground.

Only the clearing seed-eaters are found in flocks of their own kind.

Family COEREBOIDAE

Seven honey-creepers, brightly colored, are all tree-top birds except *Coereba*, which is mid-jungle and clearing. Their nesting habits are varied, *Cyanerpes cyaneus* nesting over water and laying two black eggs. Five are common forms.



Fig. 15. Nest and eggs of *Thraupis Episcopus*, the abundant Blue Saki Tanager of the research area.

Photograph by John Tee-Van.

Family TANAGRIDAE

Tanagers are well represented by twenty-two species. The most familiar birds of the clearing are two *Thraupis* and a *Ramphocelus*, the blue, palm, and silver-beaked tanagers, the latter the most abundant nesting bird in the area. The small euphonias, *Tanagra*, and the larger callistes, *Tangara*, are gregarious, haunt the tree-tops and congregate in jungle berry trees; *Cissopis* and *Lamprospiza* are solitary. No family shows more brilliant coloring, or is more decidedly an element of the tops of the jungle's tallest trees.

Family ICTERIDAE

These twelve species form an important element in the avifauna of Kartabo, and reflect the utmost variety to be found in any one family. The giant orioles, *Ostinops*, build their five-foot nests in

tall trees, and make the jungle ring with their courtship, and after the breeding season associate in flocks with toucans. The two brilliant *Cacicus* fashion shorter nests on lower trees, always in large colonies. *Cassidix* is parasitic upon all three. *Molothrus* is a stray from more open regions, and *Pseudoagelaius* from the inland savannas. *Leistes* haunts every meadow with the habits of our red-winged blackbird, and a delightful flight song. *Melanospar* nests singly in palm trees. The bobolink is a rare migrant.

Family CORVIDAE

A single species represents this northern family, the beautiful lavender jay *Cyanocorax*, whose nesting habits are still a mystery, but which is usually seen in flocks with other birds of similar size, such as toucans and caciques.

Class MAMMALIA

This is a land where birds and insects are dominant. In the quarter square mile of research area, mammals are almost the least noticeable class. A stranger to this tropical region could wander for days through the jungle and catch only the most fleeting glimpse of accourie or deer or monkey. Vocally only the howling monkeys would ever distract his attention from the sounds of insects, amphibians and birds. In numbers, in variety of adaptations and habitat, in pattern, in coloration, in vocal ability, in general keenness of the senses, the Class of which we are members is hopelessly outclassed. Mollusks, and especially shelled snails, are small, obscure and very scarce at Kartabo, and yet in point of numbers they rank with mammals.

The total number of mammals taken or observed within the research area is seventy-three, a number exceeded by all other classes except amphibians. As far as I have been able to enumerate those from the entire Colony, this is about fifty-eight percent of the whole. Bats and the smaller rodents are very inadequately represented in the list, and future collecting will undoubtedly bring the total up to one hundred.

The mammals are divided into ten orders and twenty-seven families. The only order of living Eutheria not represented in the quarter square mile is Insectivora.

In size they range from the great cow-like tapir with a weight of hundreds of pounds, to the tiniest of insect-eating bats, which weigh a bare three grams.

As in the case of the birds, a comparison of the land and fresh-water mammals of New York State with those of a quarter of a square mile at Kartabo is well worth while. In New York, Miller has recorded eighty-one species, while I have listed seventy-three from the limited tropical area—an area which is $\frac{1}{180,000}$ of that of the temperate State.

Eleven orders are represented in the two localities, of which six are common to both, one is found only in New York, and four others occur at Kartabo alone. The relative number of species is as follows:

Orders of Mammals of New York State and of Kartabo			
	New York		Kartabo
Marsupialia.....	1	....	6
Chiroptera.....	8	....	12
Carnivora.....	17	....	13
Rodentia.....	32	....	19
Artiodactyla.....	4	....	4
Cetacea.....	8	....	1
Insectivora.....	9	....
Edentata.....		....	9
Sirenia.....		....	1
Primates.....		....	7
Perissodactyla.....		....	1

New York State was originally a country varied with open areas as well as forests, while Kartabo is almost wholly jungle or river. This difference is reflected in the relative adaptive radiation of the mammals of the two localities.

Environment Adaptations	New York		Kartabo	
	Species	Percentage	Species	Percentage
Aquatic.....	3	4	7	9.5
Terrestrial.....	53	75	23	31.5
Arboreal.....	7	9.8	31	42.5
Aerial.....	8	11.2	12	16.5

If, instead of the above classification, we add to the strictly arboreal Kartabo species those mammals which are good climbers and spend much of their time in trees, we find that over 60 per cent. of the whole are more or less dependent on the jungle, while the

same test applied to the New York mammals shows only 11 per cent. arboreal.

As regards food, the seventy-three Kartabo mammals divide themselves into thirty-one which are herbivorous, thirty-one carnivorous, and eleven omnivorous.

In a relative summary at Kartabo, mammals (the group to which we ourselves belong), must be reckoned as seventh, preceded by birds, insects, fish, spiders, reptiles and amphibians. We realize that the age of reptiles and of giant mammals is past, and that the present is the age of man, insects and birds.

Many of the Kartabo mammals are nocturnal, almost all are dull-colored, and their senses of eye, ear and nostril are so keen that they are difficult of approach. The following notes which I have already published in the Zoological Society Bulletin on the mammals observed during the month of March, 1922, in the quarter square mile, will serve admirably as an introductory hint of tropical mammalian life as observed in the field.

"Only a few days after our arrival at the Station a herd of about forty wild peccaries, the collared species, came down within a hundred feet of the laboratory, and rooted under fallen logs and jungle floor debris in search of grubs and tubers. One of our party found a tree where a hacka was feeding on five successive days, and a pair of the animals on the sixth. When alarmed the hacka rushes down the trunk, paying no attention to the observer, no matter how close he may be standing, and dashes off through the jungle. A few days later a splendid black jaguarondi cat trotted past me, unhurried and in full view. I do almost no shooting within the quarter mile of area under observation, and hence let him go unharmed. So again, one day, sitting on the old stelling, when an ocelot came and sat down on a rock, we looked at one another and went our ways in peace. Three times during this month I started deer near the trail, and at least half a dozen of the big rodent agoutis have scampered away from their feast of fallen fruit with the commotion of a whole drove of animals. A jaguar has been about ever since our arrival. I found an agouti partly devoured, and the tracks of the big feline show him to be a full-grown animal.

"Every night three families of red howling monkeys roar across the river, and fresh-water dolphins come close to the shore at high tide and sigh as they exhale. Within our own area, there are at least two bands of howlers, two of cebus and one gang of beesa monkeys.

"Strangely enough we have not seen a single opossum this year, but they are here in numbers, and I occasionally hear them at night on the dining room table and running along the partitions of the bungalow. A tamandua anteater was found up a tree just back of the Station, and a great anteater eight feet in length was killed a short time before our arrival. In the stomach of the tamandua were two hundred thousand white ants or termites. Of course it would be impossible to count all these insects. Our method is to take ten cubic centimetres, and divide it into ten equal parts. In each of these there is an average of one hundred and twenty white ants, and when this divided into the accurately gauged mass of the remainder, the result of two hundred and three thousand insects is obtained. When we realize the terrible damage which these insects do to houses and furniture, it would seem the wise thing for tropical planters to encourage these long-tailed tamanduas as much as possible. With a flock of tamanduas to keep the termites down, and a colony of giant marine toads to attend to leaf-cutting ants, much more success would attend tropical agriculture.

"In the pits dug for frogs we have recently taken a spiny rat, a rodent normal in appearance until we rub its fur the wrong way, when the hairs of the back feel like the spines of a porcupine. We keep as pets the beautiful little brown and white mice which come to glean from our crumbs after dinner. Bats are abundant, and we have captured forty-three of the dusky blunt-nosed species in the bungalow, only six of which are males. Two other species have been shot, one new to us, and vampires fly around the tents every night, although no one has been bitten this year. My Indian hunter has brought in agoutis, a wild pig and many monkeys for food, and a beautiful twenty-six pound margay cat. The arboreal character of this animal is shown by its food, it having fed upon a cebus monkey, while the skin of the stomach was punctured in several places by spines of the tree porcupine.

"Thus during the month of March, without any especial search, in the course of tramps for materials dealing with special problems, we have seen twenty species of mammals, with a conservative estimate of one hundred and fifty individuals."

ENEMY AND PREY ECOLOGY

Fourteen species of vertebrates have been found feeding on mammals at Kartabo.

Enemy and prey ecology—continued

Three species of snakes feed on rodents and sloths.
 Two owls feed on mice and bats.
 Two hawks eat mice.
 Three eagles devour monkeys and sloths.
 Margay cat eats porcupines, cebus monkeys and sloths.
 Ocelot and Jaguarondi eat spiny rats.
 Coati eats opossums.

MAMMALIAN FOOD

Earthworms	<i>Nasua</i>
Spiders	<i>Nasua</i>
Scorpions	<i>Nasua</i>
Centipedes	<i>Nasua</i>
Roaches	Opossum
	<i>Nasua</i>
	<i>Molossus</i>
Long-Horn Grasshoppers	Opossum
	<i>Nasua</i>
Tree-Crickets	<i>Saimiri</i>
Beetles	Opossum
	<i>Nasua</i>
Ants	<i>Tamandua</i>
Moths	<i>Nasua</i>
Termites	<i>Molossus</i>
	<i>Tamandua</i>
Lizard Eggs	<i>Nasua</i>
<i>Cophias flavescens</i>	<i>Nasua</i>
<i>Engystoma microps</i>	<i>Nasua</i>
Small Opossum	<i>Nasua</i>
Tree Porcupine	Margay
Spiny Rat	Ocelot
3-toed Sloth	Margay
Cebus Monkey	Margay
Motmot	Margay
<i>Leptodactylus pentadactylus</i>	<i>Lutra</i>

Order MARSUPIALIA

Family DIDELPHIDAE

Out of ten or twelve Guiana opossums, six are found in the quarter square mile research area at Kartabo. The big *Didelphis*, almost exactly like our northern opossum, is a jungle scavenger. The tiny *Marmosa*, carrying sometimes ten young on her back, and the larger *Metachirus* come frequently into the pantry and laboratory. *Monodelphis* is much rarer. It nests in a small form on the ground

in grass, and feeds on beetles and roaches. The rarest of all is the *Chironectes* or water opossum, which I have seen twice but have not yet secured. All are nocturnal and, except the last, arboreal.

Order CHIROPTERA

A dozen species of bats have been recorded. Probably twice as many are present, but have not yet been secured.

Family EMBALLONURIDAE

The little river bats, *Rhynchiscus*, are common along the shore and up the creeks, roosting on the under side of tacubas and mangroves. The only other member of this family so far recorded is *Saccopteryx*, the rare sac-winged bat.

Family PHYLLOSTOMIDAE

Five species are found of which *Phyllostomus* is a very large, leaf-nosed species; the fruit-eating *Vampyrus* is the largest of all the bats occurring here; *Mesophylla* is a rare white jungle bat. I shot six out of eight, all roosting together beneath a large aroid leaf. Finally there are the very common *Glossophaga* and *Hemiderma*.

Family DESMODONTIDAE

The vampire, *Desmodus*, is not uncommon, and most of us have been bitten at one time or another, the bats entering the tents unless a lantern, turned low, is burning somewhere near.

Family FURIPTERIDAE

This flat-faced, small, delicate bat is not rare, and I have taken it in the jungle, up creeks, in the laboratory and in the tents. It is as devoid of expression as a King Charles spaniel, or a sloth.

Family MOLOSSIDAE

These are the common house bats of the Station, from twenty to sixty *Molossus* having to be ejected each year before we can work in peace. *Eumops* is rarer, but comes occasionally into the laboratory.

Order CARNIVORA

Family CANIDAE

Icticyon or hunting dog is the only member of this family found near the Station, and here it is probably a stray from the

inland savannas. A young specimen which was caught by an Indian and which he would not sell, a skull which I picked up, and a skin which was lost in transit are all the data we possess. One of my Indians has killed four near here.

Family PROCYONIDAE

Three mammals of this family make their homes here; *Procyon*, the crab-eating raccoon, is not rare along the river-banks, where its tracks reveal its nocturnal journeyings, and *Nasua*, the coati, comes through the jungle in pairs or families, tearing stumps to pieces, as arboreal as squirrels. At night the flash-light reveals the glowing eyes of the kinkajou, *Potos*, which is much commoner than is supposed.

Family MUSTELIDAE

Two giant weasels, *Tayra* and *Grisson*, inhabit the research area, the former almost common, the latter rare. Both climb trees readily, and give forth a skunk-like odor. *Tayra* will rush down a trunk in one's very face to make its escape.

Two others live in the river, the rare giant *Pteronura*, sometimes six feet long, and the more common *Lutra mitis*, which is seen now and then, playing with its young among the mangroves.

Family FELIDAE

Five cats have been identified, and there is probably another small one which has evaded observation.

The jaguar, *Panthera*, occurs occasionally, and two have been seen on the same day near the laboratory. They kill cattle across the river, but like all other South American mammals, are quite harmless to man if not wounded or robbed of their cubs.

Felis couguar, the puma, has been recorded but once at Kartabo, but three miles down the river I have seen three, and two at Kalacoon. They are small animals and quite as harmless as jaguars.

The jaguarondi, *Herpailurus*, is a handsome, long-tailed black cat, weighing about fourteen pounds. It feeds on *Odontophorus* and large insects. The ocelot, *Leopardus*, is more common than the jaguarondi, but less often taken. I have found it usually when taking a domestic chicken. The last feline is the margay cat, *Margay*, which feeds on an unpalatable diet of spiny rats, spines and all, and is seen only rarely, usually by jack-light.

Order RODENTIA

Family HYDROCHAERIDAE

The capybara, *Hydrochaerus*, is common along the river shore, coming out at night and feeding on the succulent swamp plants. They do much damage to the Indians' crops, and are in turn hunted with dogs, and are delicious eating. The wild representative of the domestic guinea pig is found in the far interior of Guiana. The capybara is its five-foot representative. Two young are born and the immature have lived with us as pets.

Family DASYPROCTIDAE

The most abundant mammal in the research area is the agouti, *Dasyprocta*. My Indian hunters and I have killed one hundred and thirty-five for eating, and yet we hardly ever take a walk through the jungle without seeing or hearing one of these red-rumped rodents. There are one to three at a birth, usually two, and although they breed throughout the year, yet the usual season for births is at the beginning of the rains. They haunt certain trees when the berries or fruit are falling, and it is seldom that a Cuyuru palm or wild plum drop their fruit without attracting many agoutis and labbas. Agoutis seem especially subject to the attacks of *bête rouge*, and their ears are usually covered with hundreds. They weigh from five to ten pounds.

The larger, spotted labba or paca, with the misleading generic name of *Agouti*, is a much more rare animal, occasionally coming close to the laboratory. These animals often suffer from enormous warble fly maggots and a host of fleas. They weigh from twelve to fifteen pounds. One, or very rarely two, young are born, usually early in the long rainy season.

The rarest of this family is the small-tailed agouti, *Myoprocta*. At Kalacoon my Indian once brought in a young animal, and at Kartabo one adult has been taken. As with spider monkeys, the Essequibo seems to be the usual barrier for them, as they are not rare on the east bank, but only occur as strays farther to the west.

Family ERETHIZONTIDAE

The tree porcupine, *Coendou*, is probably more common than we realize, but its nocturnal, arboreal habits prevent its being often found. When it blunders into an Indian's benab or into the pantry it shows no fear upon being discovered, but proceeds to seek for

edibles, knowing that no ordinary assailant dares touch it. It has an overpowering odor, especially before it becomes accustomed to captivity.

Family OCTODONTIDAE

Two spiny rats have been taken rather commonly, *Echimys* and *Proechimys*. They are strictly jungle animals, but are also found commonly on the small islands offshore. They often fall into the pits we dig at the sides of the trails. They are fifteen to eighteen inches long, and weigh less than a pound.

Family MURIDAE

The common house mouse, *Mus*, and rat, *Rattus*, have both been taken at Kartabo, the former twice, the latter once, strays from civilization down-river, but neither has obtained a foot-hold.

Family SIGMODONTIDAE

Eight species of jungle mice and rats have been taken, and many more probably await discovery. These are one *Nectomys*, a common water rat, more common on islands than the mainland, three *Oecomys*, one of which is a new species, a spiny mouse, *Neacomys*, and three *Oryzomys*.

In several of the mice I have found two or three the regular number of young in a litter, a most interesting reduction in number compared with northern species, and comparable with the reduction of the number of eggs in many tropical birds.

Family SCIURIDAE

Two members of this typically northern family occur here, a very rare dwarf squirrel, *Sciurillus*; and a common olive brown squirrel, *Guerlinguetus*, which in size, actions and voice recalls our northern red squirrel. It is one of the noisiest mammals of the jungle, and the only one which dares to remain and scold after it has detected our presence.

Family BRACHYPODIDAE

The three-toed sloth, *Bradypus*, is not common when searched for, yet we have had several dozen during the years of occupancy, and they are probably much more numerous than we imagine. They are good swimmers and I have records of eleven crossing the rivers. I have written a monograph of this species, which will follow this ecological account of Kartabo.



Fig. 16. The Three-toed Sloth, *Bradypus*.

Photograph by William Beebe.

The two-toed sloth *Choloepus* is a much rarer inhabitant of the jungle hereabouts. Sloths are of course wholly arboreal, they are solitary and feed on the leaves of only a very few species of trees.

Family MYRMECOPHAGIDAE

The three ant-eaters form a remarkable triumvirate of mammals specialized for a single type of food. The great antbear *Myrmecophaga* is terrestrial, solitary and rare, being seen only once in a great while. I have sent three live ones up north, the last of which we secured after a long fight from boat and shore. It reaches a length of nine feet over all, and is wholly terrestrial.

The tamandua, with an identical generic name, is much more common, as we have secured about fifteen specimens. It is of medium size, weighs eleven to thirteen pounds and is arboreal, feeding both in the trees and on the ground. The last one examined

contained about 50,000 ants and termites, the proportion being about five of the former to one of the latter.

Cyclopes, the rare silky anteater, has been recorded only twice, and captured once. Small, nocturnal, arboreal, it may be more numerous than we know.

Family DASYPODIDAE

Four species of armadillos live in the quarter mile of research area, the giant armadillo, *Tabassous unicinctus*, which I have seen three times, but secured only twice. An adult measured four feet, six and a half inches, and weighed seventy pounds. The nine-banded armadillo *Dasypus* is less common than the eight-banded one, *Tatu*, whose holes are seen here and there in the jungle. As rare as the giant species is the smallest *Tatoua* of which only two live specimens have been recorded. Jungle scavengers, living alone, and coming out at dark, armadillos are seen only when one sits quietly in some trail.

Order PRIMATES

Family CALLITRICHIDAE

Like tailed agoutis, marmosets, *Cercopithecus*, are rare west of the Essequibo. Five records at Kalacoon and Kartabo are all I have, all in moderately low jungle, all tame, yet scolding loudly.

Family CEBIDAE

Six species of monkeys occur at Kartabo. Red howling monkeys, *Alouatta*, are the most abundant. About seventy-five have been killed for specimens and for eating, and yet in 1924 they were more numerous than ever, nine separate bands being within hearing of the Station. The roaring chorus is the loudest, most awesome and most remarkable of all jungle sounds. They favor high trees in swampy jungle. The white-headed saki or beesa, *Pithecia*, ranks third in numbers and lives in dry jungle. They are silent and only a faint cough reveals their presence. *Saimiri* or squirrel monkeys go in large bands but are very irregular, being common some years and almost absent others. A single specimen of *Saimiri cassaquiarensis* is probably a stray from the Brazilian frontier. The spider monkey, *Ateles*, is rare west of the Essequibo, only two having been observed. *Cebus*, the ring-tailed capuchin, is the commonest monkey next to the howlers, going in large gangs, noisy and quite

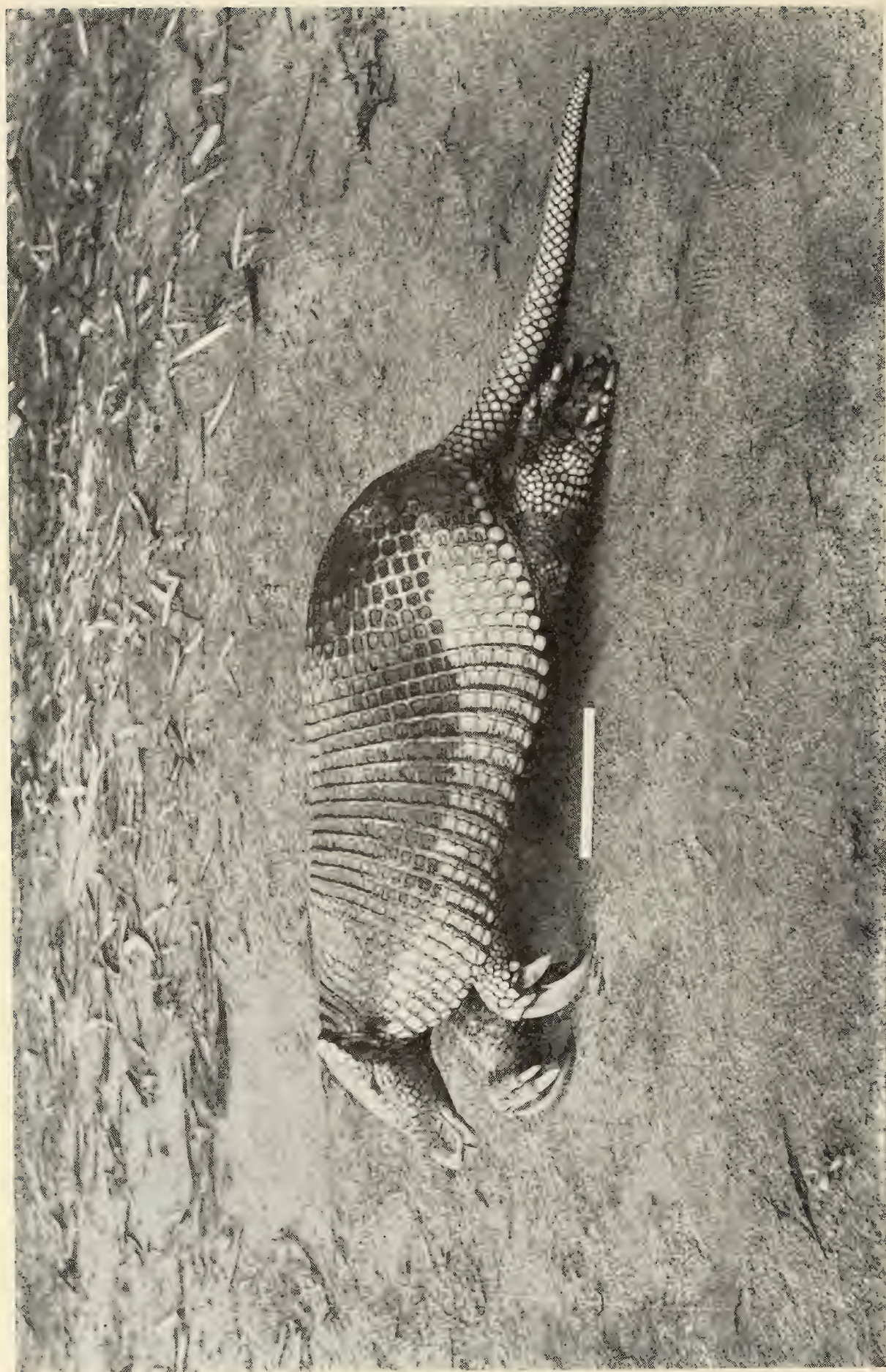


Fig. 17. Giant Armadillo; a rare creature and one of the most difficult to keep alive.

Photograph by John Tee-Van.

fearless. About sixty have been collected, to no appreciable extent diminishing their numbers.

Order ARTIODACTYLA

Family TAYASSUIDAE

Two peccaries are found here, both rather surprisingly being new subspecies. The big white-lipped *Tayassu pecari beebei* is rather rare, but found in large herds when it does occur. The more common collared peccary, *Pecari tajacu macrocephalus*, goes in pairs, families or small herds, and not rarely occurs close to the compound of the laboratory. We have not found them dangerous unless wounded. About forty-five have been killed for specimens and food.

Family CERVIDAE

Two deer, *Mazama*, a large red brocket and a smaller brown one are found, the latter being much more common than the red deer, the proportion shot being about ten to one. They are both small, as deer go, and wholly jungle animals, solitary, or the doe with one fawn.

Order PERISSODACTYLA

Family TAPIRIDAE

The bush cow or tapir, *Tapirus*, is a rare animal in the research area. About one each year is killed and I come across tracks now and then in the deeper parts of the swamps. On February 29th, 1924, a large one was shot close to the laboratory. They are usually found in pairs.

Order SIRENIA

Family TRICHECHIDAE

Twice among the mangroves I have seen manatees, *Trichechus*, and they are not uncommon in the shallows near the creeks across the Mazaruni River. I have taken no specimens since leaving Kalacoon. Near the coast they are numerous, and breed in the Botanical Gardens at Georgetown.

Order ODONTOCETI

Family PLATANISTIDAE

Fresh-water dolphins, *Inia*, are seen on an average of once a week, rolling past as they go up-river, or milling around, feeding in

front of the laboratory. In the shallows between the islands across the Mazaruni, as many as a dozen, old and young, have been seen. Usually from two to six are seen together. The fishermen now and then catch them in their nets. In spite of utmost efforts I have been unable to obtain a specimen.

VII—HISTORY OF KARTABO AND BARTICA DISTRICT

Almost four hundred years ago the fable of El Dorado was credited all over Europe, and created great excitement and a thirst for adventure among all classes of people. This wonderful city of gold was supposed to be located in Guiana, which was, it was said, an empire not inferior to those of Mexico and Peru, and such men as Raleigh formed magnificent conceptions of the civilization to be found beyond the barriers of jungle.

The fabulous city was first known as Manoa, but a Spaniard named Martinez, who claimed to have been there, called it El Dorado, for, he said, on the occasion of a feast the Emperor and all his captains, having first been rubbed with balsam oil, were then covered with gold ground into a fine powder, "until they be all shining from the foot to the head."

The wealth of Guiana was not the only marvel reputed to be found there. The tribe of Amazons, and the headless people whose faces were on their breasts, and the two-fingered negroes were some of the wonders of the country, according to the old tales.

When Columbus made his third voyage to the New World in 1498, he saw the distant northerly coast of Guiana but did not land there. Throughout the 16th century adventurers sought for Guiana, and of course more particularly for El Dorado. Men of all nations tried to be the first to reach the marvellous city where even the most common articles were made of purest gold.

In 1595 Sir Walter Raleigh made his first voyage of exploration up the Orinoco, concerning which he wrote "The Discoverie of Guiana," best of all Elizabethan narratives of adventure, but which was received with incredulity. In 1617 he made a second voyage thither,—a voyage which was a series of disasters.

While Spanish, English and French were eagerly searching for gold, the Dutch were busy trying to build up trade with Guiana. As early as 1580 they had established a settlement on the Pomeroon River, called Nova Zeelandia, and a similar post on Abary Creek,

known as Nibie, or Bush-rope Town. After some years roving bands of Spaniards made the Pomeroon settlement untenable; the inhabitants retired into the interior and went to the point where the Cuyuni River flows into the Mazaruni, just before the latter joins the Essequibo. There they established their headquarters on a tiny island opposite Kartabo Point, which they called Kyk-over-al, because of the wide view it commanded.

This is the earliest settlement in Guiana of which anything remains. When these first settlers came they found there the ruins of a small Portuguese fort, the history of which was unknown even in those days and has remained so.

For a hundred and twenty-four years this dot of land at the confluence of three great rivers was the seat of government of the Dutch colony of Essequibo, which included the extensive region between the Abary and the Orinoco. At first it was chiefly a trading post, where axes, knives, beads and trinkets were bartered with the Indians in exchange for cotton, anatto dye, hammocks, balsam, copaiba and tobacco.

In 1616, soon after Kyk-over-al was settled and christened, this tiny struggling colony was so fortunate as to acquire a man of authority and foresight to direct its destinies. This man was Gromweagle, a Dutchman who had served under the Spanish in various Orinoco expeditions, and had thus acquired so great a liking for Guiana adventures that he sought employment in that part of the world from his own countrymen. He was sent out from Zeeland with three ships, "and was the first man who took firm footing on Guiana by the good liking of his neighbors, whose humours the gentleman perfectly understood."

He rebuilt and strengthened the fort on Kyk-over-al and adopted it as his stronghold. During his time the colony flourished; he was sufficiently wise to adopt a friendly attitude towards all colonists in this part of the world, even carrying this radical policy so far as to trade with the Spanish and English. This, at a time when Dutch, French, Spanish and English were at each others' throats over the question of colonization, and jealousy and suspicion were almost universal among them, must have been a striking phenomenon.

In 1621, the Dutch West India Company was incorporated, and immediately began the introduction of negro slaves. Labor was naturally the crying need of the colonists, for though the land was fertile, the enormous amount of toil required to prepare the jungle

for cultivation needed many more men than had yet been tempted to come from Europe. The climate too, was a serious drawback to a white man's attempts at field labor, and its deleterious effects were not diminished by the quantities of alcoholic refreshment which were considered necessary to repel the dreaded fever. It had been found impossible to persuade the neighboring Indians to look with favor upon honest toil, so the momentous step was taken of importing African slaves.

Three years after this a regular garrison with a Commandeur was sent to Kyk-over-al, which thus became army headquarters as well as trading-centre and prison. Looking to-day at the dimensions of the island, it is hard to believe the records which state that at one time there were more than two hundred soldiers quartered in this small area. They must all have been slaves to the recently discovered vice of smoking, for at the present time it is possible at low tide to retrieve vast numbers of clay pipes from the mud under the ruined walls of the fort. Other relics are there too,—lead bullets and iron cannon-balls, to recall the purpose of this fort in a time of alarums and excursions, fragments of old pottery from the feasts of bush-meat that these sturdy old pioneers enjoyed, and now and then a bright little Dutch bead brought from the far-off Netherlands to tempt the dark and taciturn Indian to part with his small store of cotton or tobacco. Of the fort itself, there remains the archway built of narrow bricks also imported from the mother-country; staunchly fashioned, it still stands, resisting the creeping jungle fingers that seek to pull it down, but the walls, to whose enclosure it once gave access, have crumbled or been carried away to furnish building material elsewhere.

Dutch cultivation spread up the Essequibo, and less extensively up the Mazaruni and Cuyuni. At this time most of the pioneers' efforts were directed toward establishing plantations in the interior, and the subjugation of the jungle went slowly and painfully on.

In the meantime other parts of Guiana were settled. A Dutch colony on the Berbice, English ones on the Surinam and elsewhere, and scattered French settlers on the Cayenne. Up to the beginning of the 19th century Guiana colonies went through a dizzy succession of changes in ownership; British, Dutch and French captured, surrendered and recaptured, while the bickerings between the West India Company and the colonists' Court of Policy were endlessly complicated.

In 1666, an English expedition from Barbados captured Kyk-over-al, but in a few months the English who were left to guard the settlements of the Essequibo district were reduced to thirteen men. They had suffered much hardship through counter-attacks and lack of supplies and were soon forced to surrender to the Dutch.

In 1670, Hendrik Rol was in charge at Kyk-over-al, and during the next few years the West India Company had four large plantations near-by. There was one called Vryheid where Bartica now stands, those of Duinenberg and Fortuin near the present site of Kalacoon House, and Poelwyck on Caria Island.

In 1708, a French privateer under Captain Anthony Ferry sailed up the Essequibo, burning and plundering such settlements as he encountered. Having reached Vryheid, he successfully raided it and the neighboring plantations. The planters took refuge at Kyk-over-al where the Commandeur, one Van Der Heyden, refused to give battle on their behalf, since he had but fifty men to the privateer's three hundred. Ferry sent an officer with a flag of truce to demand ransom, threatening to burn all the estates if this were refused. Van Der Heyden capitulated and agreed to pay fifty thousand florins in slaves, provisions and cash, if Ferry would go without causing further damage.

Richard Schomburgk, who travelled extensively in the interior of Guiana in 1840-1844, gives an interesting account of the origin of the settlement on Kartabo Point, where he went to recruit hands for his inland journey. He says, "The evening having become unusually dark and stormy, we determined to spend the night at Kartabo and return to Bartika first thing on the following morning. The obliging and friendly coloured folk supplied us with hammocks and, though not asked, cleared out a house for our night's quarters, the paddlers preferring the benches and ground spaces. We were up and about by break of day, which gave me an opportunity of having a look over the whole settlement and its occupants.

"The large number of coloured people who inhabit the Essequibo and Mazaruni are mostly descendants of Europeans, negroes and Indians; all belong to the Established Church, and generally stand on a higher plane of civilization than the surrounding Indians. They are the purveyors for the most part of the dried fish supplied to the city, just as they are the builders of the punts, lighters and corials used on the estates, in the manufacture of which they develop unusual

skill. In not too stormy weather, one can even trust oneself at sea in these boats. There is an historical reason for the settlement of this isolated coloured colony here at the junction of three rivers. In the year 1738 some forty odd creole slaves on the possessions of the Dutch Company banded themselves together, secretly left their estates and fled to the Cuyuni where they settled on an island that is still called Creole Island, cultivated some land, and at the same time entrenched themselves fairly strongly. The news naturally had a disquieting effect upon the Governor and plantation-owners, as it was feared that the example taken might be repeatedly followed.

These fears were further increased when the runaways, in their presumption, went so far as to inform the Governor through some Indians that if he wanted to make slaves of them again he must come and fetch them, not only with the whole of his forces but with those of Holland as well, and that they were accordingly awaiting him with confidence in the firm conviction of seeing the attempt on his part completely frustrated. The Governor recognized their advantageous position and at the same time all the difficulties to be encountered in the way of successful attack; he therefore deemed it far better to conclude a favourable treaty than to put to a test the uncertain fortunes of war. A certain Peter Tollenaar, a mulatto, was despatched, unarmed, for the purpose of discussing peace-terms with them on the following lines,—if they did not extend their raids into the Colony but worked every second month for it, and at the same time gave assurance not to entice away any more slaves, the Governor would give them and their descendants their freedom. Peter Tollenaar was successful in his efforts on behalf of peace and from that time up to Emancipation this free and coloured population continued its existence. To prevent their children falling back into slavery, the men were at first allowed to marry only free Indian women.”

For some years there had been a gradual migration toward the coast-lands, for though the interior was far more healthy, the difficulty of combating the jungle, together with the realization that the soil of the coast was better suited to the raising of sugar cane, had determined many planters to brave the miasmas and malarias of the littoral regions. In 1740, under Governor Storm Van Gravesand the seat of government was removed to Fort Island near the mouth of the Essequibo, and the Demerara region began to be more thickly settled. Those of the planters who had not preceded the

Government's move now followed it, and Kyk-over-al was abandoned forever.

Although the Dutch had gone, they left behind more than a deserted fort and a few plantation buildings. That inevitable result of slavery, the half-breed, was present in numbers. In the earlier times the planters had bought Indian slaves from the Caribs, who raided the villages of other tribes and trafficked in their captives. Down to the end of the 18th century Indian slaves were still held, though the trade was prohibited. Thus in every settlement there were the children of Indian women and white men as well as the offspring of African and white, and, in smaller numbers, the results of Indian and negro matings, despite the Indians' dislike of the blacks.

The majority of these people stayed in the jungle after the Europeans had left, and since most of them were totally lacking in the energy which they might have inherited on the paternal side, they relapsed at once into indolence, and did only as much as was necessary for bare existence. Soon the encroaching forest was quietly reclaiming its own, and to-day the gaping archway of Kyk-over-al, leading to nothing but weeds, seems symbolical of the Dutch occupation of this region and its human residue.

There was practically no Government control of this upper region; there was no interest in it, unless runaway slaves were to be hunted, and they seldom got so far as Kartabo, for the Indians were subsidized by the planters to hunt them down. The locality became a sort of refuge for the destitute and for law-breakers, and presently a word was coined to designate these people of three bloods and no race. On the coast they were carelessly referred to as the ones who lived "above yonder," and this becoming corrupted to "boviander" has come to be the name of a people good-natured, shiftless, ignorant and easy prey to disease.

Our nearest neighbor at Kartabo, a boviander woman with kinky hair and coffee-colored skin, used to tell us proudly that her great-grandfather was Governor Van Der Heyden, and that the great tree which overhung our bathing-beach was used for a gallows in the days of which her grandmother had told her.

The strange combination of races resulting in the bovianders, and their proximity to the native Indian tribes has produced many interesting and romantic tales, and it is a pity that so many must have been lost through lack of some one to record them.

A reference to an island that was very likely Kyk-over-al is quoted from an article by Mr. James Rodway in *Timehri* of 1896; "The Indians did not always agree with the bovianders, and in 1805 Postholder Linau was sent up the Essequibo to reconcile the parties in dispute. He met with an Arawak who had abandoned his home because the mulattoes had frightened him with a report that the Acawoios and Macousis were coming down to murder them all. He found the bovianders from Essequibo, Massaruni and Cuyuni congregated on a small island as they said for defense against the Indians."

Bartica was chosen as the site for a mission station in 1829, and this project appears to have flourished for some years, as Schomburgk wrote of it in glowing terms after he visited it in 1841. He particularly described the school for Indian children, whose parents emerged from the jungle once a week on the day when they were permitted by the missionary to visit their offspring. However, when im Thurn was there in 1878, it was abandoned and in ruins.

On the Mazaruni River, on the opposite side from Bartica and a few miles above it, the bank is steep,—almost cliff-like. Here there once stood the residence of a Post-holder, but in 1841 the abandoned house was pulled down and the Penal Settlement was built. This establishment has never been abandoned for lack of patronage, and the fact that it occupies one of the most beautiful and healthy spots in the Colony might almost be regarded as an inducement to crime. The prisoners are mostly negroes and "colored" men, a few Hindus, and rarely a wretched Indian, who neither comprehends the nature of his crime nor the punishment for it. The state of mind of such a captive affords a striking contrast to the equanimity, verging on positive enjoyment, with which most of his colored fellow-inmates regard a sojourn at this spot.

About 1881 gold was discovered in the upper Mazaruni district, and in the wild enthusiasm roused by this find, it almost seemed as though the long-sought El Dorado had been reached at last. Bartica, originally settled as a mission, became the boom town of the gold rush, which has steadily grown in the succeeding years. It was still further augmented not long ago when the discovery of diamonds was made in the same region, and the reports of the housing conditions in Bartica equal the horrors of the slums, though the climate renders sleeping in the streets a pleasure rather than a hardship.

At present the only means of reaching the gold and diamond

fields is by water, and at all hours of day or night one may hear from Kartabo Point the chanteys of the "pork-knockers," as they paddle up the wide river to their tiny claims deep in the jungle. Plans for building a railroad to open up this district are being considered and some day this portion of primitive forest will be as well known as the sugar estates of the coast.

SUMMARY

No fossil remains of extinct animals occur near Kartabo, and no evidences of prehistoric man, except for a single, very beautiful stone axe, which was dug up within two hundred yards of the Research Station.

To-day we are the last white settlement up-river. Three miles below on the north bank of the Mazaruni, is H.M.P.S. just visible as a group of low buildings, and on the south bank the red roof of Kalacoon appears above the jungle, occupied as the Research Station in 1916 (vide *Tropical Wild Life*, Z.S. 1917). Above us on the Mazaruni are a few scattered benabs of half-breeds or bovianders, and of Akawai Indians. Boat-loads of blacks pass up-river in search of gold and diamonds, while a small Government launch plies once a week up the Cuyuni to the foot of the first falls. Connection with the outside world is through small Government steamers which make three weekly trips between Georgetown and the Penal Settlement.

With these exceptions, the race of man exists only by hearsay in these happy regions.

ZOOLOGICA

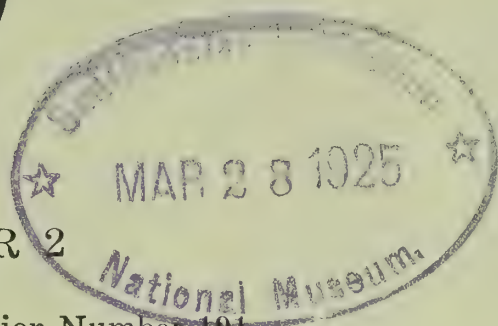
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KARTABO, BRITISH GUIANA



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THE VARIEGATED TINAMOU

Crypturus variegatus variegatus (Gmelin)

BY WILLIAM BEEBE

Contributions to the Life History and Anatomy
Of the Birds of Kartabo, Bartica District
British Guiana

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THE VARIEGATED TINAMOU¹

Crypturus variegatus variegatus (Gmelin)

BY WILLIAM BEEBE

Contributions to the Life History and Anatomy
of the Birds of Kartabo, Bartica District
British Guiana

Besides the life history, my object in this résumé of certain characters of the birds of Kartabo, is to present a study of the hyoid and of the syrinx, combined and correlated with the voice itself. I have supplemented this with other characters which Ridgway and Chubb have necessarily been compelled to give inaccurately from dried skins, such as total length, or have quite omitted, as extent, weight, tongue, hyoid, the fresh, unshrunk tarsus, etc.

THE VARIEGATED TINAMOU

Crypturus variegatus variegatus (Gmelin)

(Plates A-B; Figs. 18-22 incl.)

Type Description: *Tetrao variegatus*, Gmelin, Syst. Nat. I. 1788, p. 768 (Gujana).

Names: *Colonial*; Small Maam, Mamoo Swagger. *Akawai*; Orri-orri.

Field Characters: Medium-sized tinamou; head dark; upper parts, wings and sides black, narrowly barred with buff; neck all around and breast chestnut; chin, throat and abdomen white.

Haunts: Floor of the jungle, rarely coming to the bank of the rivers, and never into clearings. I have found them both in low, almost swampy spots, and on high, dry, sandy ridges.

Abundance: Second to *Tinamus major*, and away from the rivers probably exceeding it in numbers. Within the research zone of a quarter square mile at Kartabo, I have counted, with no duplication, the calls of sixteen individuals in the course of an hour's continuous walk.

Home Range: By means of slight peculiarities in the call-notes, I have been able in two instances, to locate with certainty the home range of the Variegated Tinamou. One bird, a female as it ulti-

¹Contribution, Department of Tropical Research No. 191.

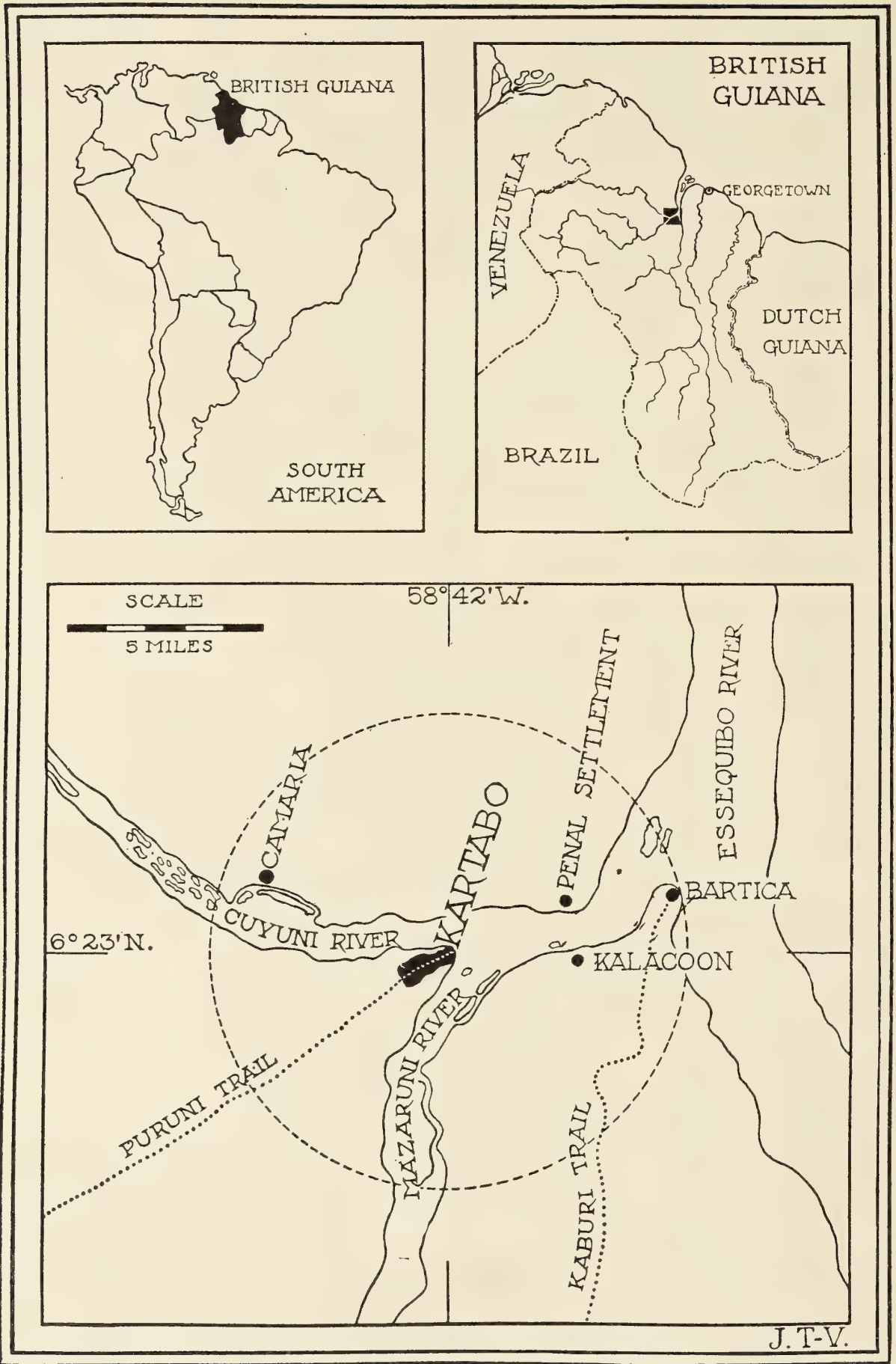


Plate A. British Guiana Tropical Research Station of the New York Zoological Society.
The circle represents a radius of six miles.

mately proved, was always to be found in one of two small snarls of lianas and underbrush within the hundred foot square of AA₂₆. Any time during the night the bird could be flushed from this spot. In the morning about 5:30 she began calling, timidly at first, then with more assurance. As it grew light she left her retreat and moved slowly west across one of our trails and then turned south to several trees with fallen fruit. Here the calling ceased for about half an hour and then recommenced as she retraced her steps, turned west again and went on until I lost her in the maze of thick jungle. Her last call was given about seven o'clock. During the period of a full month she followed this identical routine every one of the eighteen mornings on which I trailed her, with a single change to a new feeding ground when the supply from the first gave out. On five evenings I found her back in the brush pile, when she began a new period of calling, usually beginning about 5:15 and continuing intermittently until nearly seven o'clock. A third period is often marked among these birds, from nine to ten P.M.

Geographic Distribution: This form of tinamou extends to Venezuela and north Brazil.

Sociability: These birds are decidedly solitary, found together only by accident for an hour or two when feeding under the same tree, and for little longer when the mating takes place.

Specific Individuality: The partridge-like gait is like that of other tinamou; the flight is sudden, noisy and direct. It is wary even when never shot at, and suspicious of any unusual sight or sound.

Intercommunication: The calls I have described in "*Tropical Wild Life*," p. 268. An important addition is the preliminary note. Before the beginning of the regular staccato trill, a single, high, sweet, long-drawn-out note is uttered, of about two seconds' duration, followed by an interval of three or four seconds, when the call proper is given. Rarely, when the bird becomes suddenly suspicious, the first note is given alone, but almost invariably it is the precursor of the call. Once I heard a low *chuck! chuck!* uttered by a male with a half-grown chick in tow. When the birds rise they are always silent, unlike pheasants, no matter how terrified they may be. On moonlit nights I have heard their usual call at intervals throughout the night, on cloudy days it is sometimes uttered at noon, while during no month of the year is the Variegated Tinamou wholly silent. It is, of course, always given from the ground, and probably

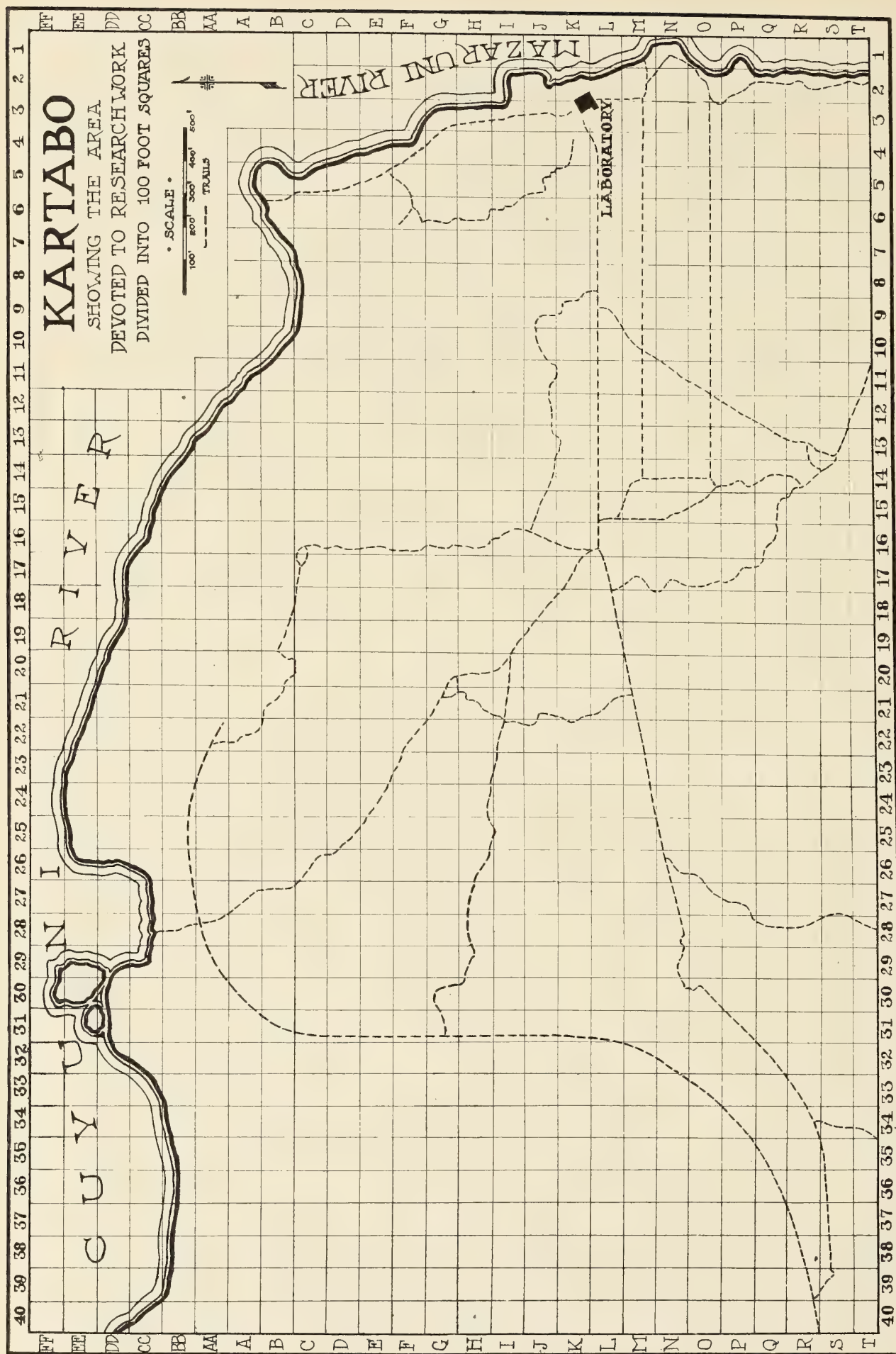


Plate B. Area devoted to research at Kartabo.
Drawing by John Tee-Van.

nine-tenths of the utterances occur between 5:00 and 7:00 P. M. and 5:30 and 6:30 A. M.

The first note of the call is usually on F natural, and is very sweet and penetrating, with considerable carrying power, being audible for long distances through the jungle. Several times I have heard these birds across the Cuyuni River, almost a mile away. It is a characteristic vocal utterance of solitary birds which inhabit deep woods, taking the place of motion, elaborate plumage, pattern and color of birds which have more of a chance to communicate by sight.

There is only slight variation in the calls of these birds; five individuals, whose notes I studied carefully, were unmistakably distinct; one had an unusually high tone, two others a nasal break, either in the first or second note, a fourth always uttered two, short, preliminary notes instead of a single long one, and the fifth called so regularly from exactly the same spot each evening and morning, with invariably seven notes in its refrain, that there was no doubt about its being the same bird week after week. I shall have more to say of the voice of this bird under courtship.

Natural Enemies: Three times I have found the feathers or other remains of this species in the jungle, once accompanied by the tracks of a margay cat or ocelot, and again by the pugs of some smaller carnivore; another record is of feathers of a tinamou in juvenile plumage, in the stomach of a spectacled owl.

Variegated Tinamou are naturally timid birds with a regular system of escape. When flushed in deep jungle they rise with a sudden rush of wings and scale off for twenty or thirty yards. They then come to earth and freeze for ten or fifteen minutes. If, as rarely happens, their landing place is accurately located, either by actually seeing the bird descend or the leaves moving, it is an easy matter to approach quite close and watch the bird for some time. It never moves while under surveillance, but stands like a bit of mottled jungle debris with its eye full upon the disturber of its peace. Nine times out of ten, the individual flushed evades all scrutiny or search. Even more than *Tinamus major* the plumage of this species merges with the jungle floor. There is no doubt that the birds unconsciously trust to their protective coloring, both in permitting a close approach at first, and in freezing after the escape dash. When one is crashing through dense undergrowth, the birds escape by creeping silently to one side, as I have now and then

observed when crouching at one side and watching the progress of one of my party near by.

Few individuals are free from ticks and *bête rouge*, two or three of the former being often scattered about on the face or between the upper scales of the legs, while the latter pests occasionally form large sores on the occiput and hind neck, with scarlet patches of the mites on the lores.

Once I saw a bird collide with a tree-trunk and fall stunned, although it ultimately recovered. But I believe that such accidents, due to imperfect steering ability, occur more frequently in the large tinamou than either in *Crypturus variegatus* or *soui*.

One bird brought in by an Indian hunter showed all the symptoms of old age,—worn beak, roughened tarsi, skull thicker than usual, and its flesh was unusually tough. I had, of course, no means of knowing how old it actually was.

Natural friends: These solitary birds seem to have no especial association with any other creatures of the jungle; more than once I have seen them stop feeding and look up in alarm at the warning rattle of an ant-bird which had discovered me, but this recognition of the quality of alarm in other birds' notes is common to most of the jungle fraternity.

Food: Of fifty stomachs, all contained vegetable matter, there being, in addition, insect remains. Small berries or fruits form almost the whole vegetable diet, many cherry-like with round pits, wild plums with oblong stones, hard acorn-like seeds, and occasionally fleshy fruits without pits or seeds. Of the four containing animal matter, number one had unidentifiable insect remains; number two, several small beetles and wire-worms; number three, a harvestman and a small beetle, and number four a roach.

All the food is procured on the ground, and the birds in company with accouries have favorite berry trees, under which, at the season of falling fruit, they may be found day after day.

Roosts: Variegated Tinamou are as solitary in their roosting as in other ways; they roost on the ground, or, as in two cases at least, on fallen logs a few inches up. Usually the choice of a place is deep within a tangle of lianas and vines, from which the bird could not possibly take immediate flight. The persistence and lengthened duration of these spots are shown by the considerable amount and limited locale of sign. I have kept close watch on a bird which eventually proved to be female, through a brief period

of intensive vocal courtship, and neither during it nor afterwards did the tinamou fail each night to roost by herself in her solitary tangle.

Breeding: My breeding records of this species, taken as a whole and including breeding adults, half-grown birds and eggs, show an unmistakable correlation with the seasons. They are as follows:

February	0	August	2
March	2	September	2
April	3	October	1
May	7	November	0
June	5	December	1
July	8	January	0

The half-grown young birds must be shifted into their rightful place in the month preceding their capture, and the egg of nest number 107 collected on July 4th with chick ready to hatch, must be accredited to June. There results a low average level for the duration of both dry seasons, and the short wet one, while a well-balanced peak of greatly increased breeding arises during the long rainy season, culminating near its beginning in May.

There are only three months during which I have no record of breeding and these would undoubtedly be filled up if I had more thorough knowledge of the field under observation. The calling of the females during every month would indicate that there is no absolute cessation of breeding, as there is in the case of *Tinamus*. This is undoubtedly directly correlated with the remarkable difference in nesting habits,—the simultaneous brooding of four to twelve eggs of *Tinamus*, and a single laying, repeated several times in succession, in *Crypturus*. The males of these tinamou take full charge of the single egg and the subsequent rearing of the chick. As I have mentioned elsewhere (p. 202) I have found a male, attended by a three-quarters grown chick, incubating a newly laid egg.

I should not like to make any assertion as to a single male taking charge of more than three eggs in succession, but from two-month period reawakenings of vocal calling in the vicinity of a single nesting area, and the number of young secured or reported from that place, I am quite sure that three eggs, one after the other, were incubated. It is interesting to note that the same female, judging from the break in a preliminary note of its call, in the time under consideration, underwent at least three other periods of song develop-

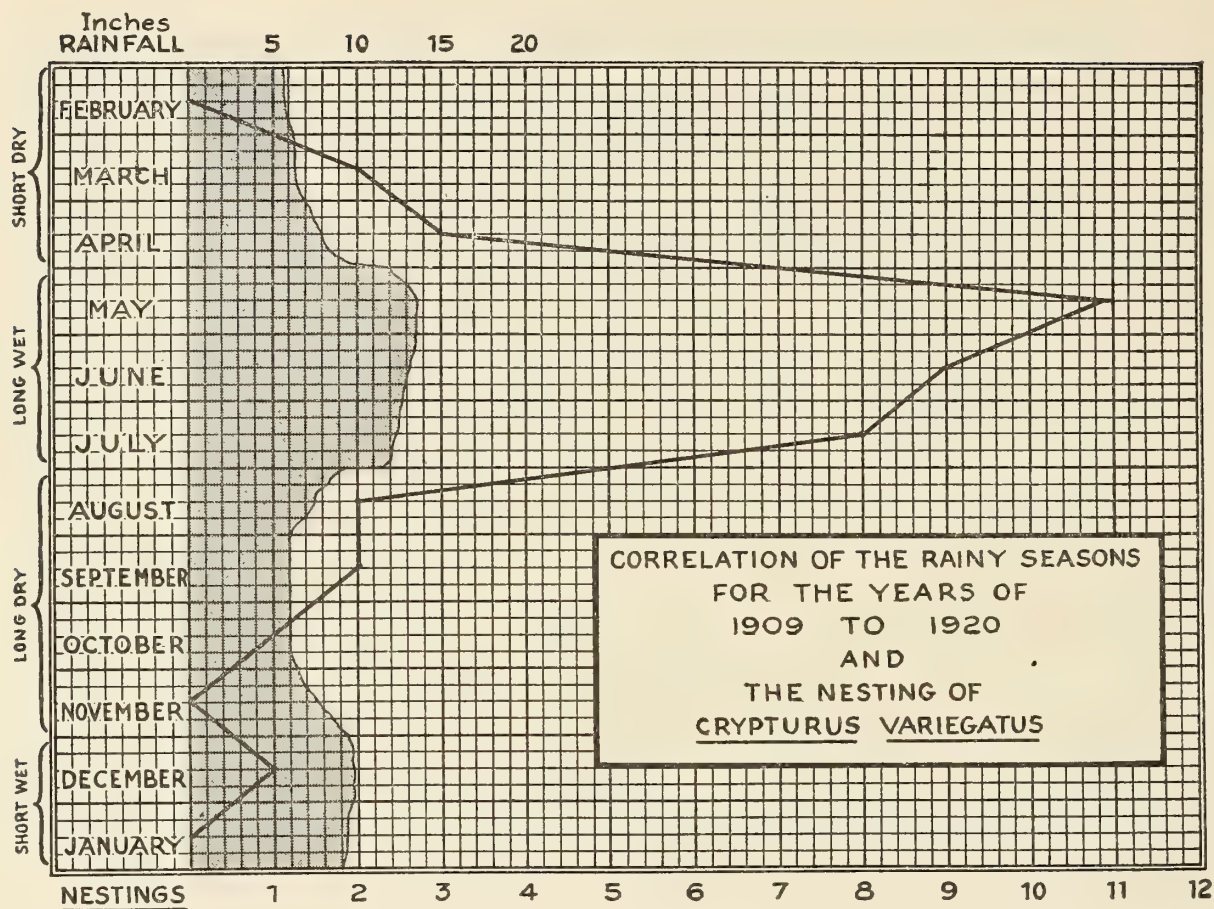


Fig. 18. Correlation of the rainy seasons and the nesting of *Crypturus variegatus variegatus* (Gmelin).

ment in an area somewhat to the northward, and although I could never locate a nest or a brooding male there, it is probable that she was courting if not actually laying eggs for another male bird.

In addition to this instance, at the end of March I have secured a male Variegated Tinamou with one-third of the juvenile plumage still on the body, incubating an egg with a week-old embryo, and twice I have seen half-grown young birds in company with a single adult, presumably the male parent. My early experience with these birds indicated the remarkable proportion of sexes of eight males to one female. I now have a much larger series for comparison, and of forty birds secured within the area under observation, thirty-two are males and eight females, a very exact proportion of four to one. This is very probably the correct percentage.

Almost all of the usual calling is done by the females, while the more excited vocal courtship is wholly feminine. Only once have I ever heard two birds directly answering each other, and on this same occasion I had my first glimpse of tinamou courtship. The male (presumably) was perched on a fallen log near my hiding place,

while an approaching bird (later proven a female) came slowly, by short quick runs, from a bit of open jungle farther west. In the intervals between runs she gave utterance to a veritable ecstasy of calling—the usual dignified, deliberate scale being run and jumbled together, in an excited, high-pitched flood of tone. The male answered from time to time with the usual call, quite unexcitedly; with perhaps several months of brooding cares behind him, and more to come, we can hardly blame him for a restrained, philosophical exhibition of emotion. As the female approached, her runs became shorter and more irregular, her body plumage flattened, the head and neck were raised almost straight, and with rapid, mincing steps, her body vibrating with the effort of the continuous notes, she zigzagged toward the calm recipient of her attention. An abominable ant-bird discovered me at this moment and rattled and screamed his loudest. Both tinamous seemed to perceive me at once, the male slipped off his log, and the female rose in a sharp, twisting spiral and I shot her as she turned, to make certain of the presumed fact that it was indeed the females which did the courting.

A few weeks later I was hidden between two fallen logs waiting for a quadrille bird to return to its nest, when a tinamou walked into view, jigged, I might have said, for the bird was stiff-legged, and taking little mincing steps which shook her whole body and scuffed up the fallen leaves. It was exactly the tremulous heel-walk of an East Indian dancer when, with motionless body, he moves or almost floats across the floor with short, rigid, almost imperceptible jerks. The tinamou revolved slowly, and when her tail came around into view I could hardly believe it was the usual dull-hued species. The tail, or rather the ten, loose-vaned feathers which represent this almost obsolete organ, were upright, thereby pushing up all the elongated feathers of the lower back and rump. Closely applied behind were the under tail-coverts and even the feathers of the flanks, which now, flattened and with much of their surface exposed, proved to be really brilliant in color. With a shaft of sunlight striking them they fairly glowed; the tips of the tail feathers were buffy brown, then came a row of rich chestnut, then two rows of pale creamy buff with semi-circular narrow bands, then a beautiful patch of variegated feathers, white-tipped, with broad black and russet red bars, and finally the softer, black-banded flank feathers. The wings drooped, the tips nearly touching the ground, the beak pointed upward, and the rich cinnamon breast feathers were puffed out.

Three and a half turns did the courting bird make before she pirouetted behind the second log. What followed I did not see. I knew that the least movement on my part would send the bird headlong. My quadrille bird subsequently returned, I learned what I wished about her, and then, stiff from a prolonged squat, I arose painfully. Like a shot, two tinamou were up and bludgeoned off. Not a sound had they uttered, and after the faint scuffling of leaves which continued for a few moments after the bird disappeared, I had no knowledge that any tinamou remained in the vicinity.

The proportion of the sexes makes it almost certain that these birds are polyandrous, although, judging by the slender spatial and temporal bond between them, promiscuous would probably be the more appropriate term. The lack of spurs and the insistence of vocality indicates that courtship and rivalry are carried on in lady-like fashion.

It is difficult to imagine more remarkable contrasts than in the breeding habits of these two genera of tinamou. There are hardly any radical differences, either external or internal, between them, and no specialized characters on the part of the *Crypturus* males to help carry them through the long months of arduous incubation and feeding of the young. The single egg and young are the only factor of amelioration in this unusual achievement. And the life of ease of the female has no apparent compensation, unless it is the need to be so much more on the constant lookout for the dangers to which her continual calling must subject her.

Nesting site: Of six nests found within the quarter mile of jungle under observation, three were in dry, moderately flat jungle, two in somewhat swampy places, and one on a trail half-way up the slope of a low hill. They are apparently chosen without any thought of escape, for in three instances when the bird got up, it either struck against intervening lianas, or had some difficulty in getting away clear. There is little doubt but that the site is chosen by the male; the hen tinamou sticks too closely to her calling place, her feeding and roosting areas to do more than court the male and lay her single egg. Once I was sure of a second site being near a former one. I took an egg in a damp low bit of jungle, and a week later flushed the bird from a new, well-formed, but as yet eggless hollow eight feet distant from the first. He did not however, return after this second alarm.

Nest: No attempt is made to form a nest. Attracted by some

unknown choice, a spot is selected, and is made into a home literally by squatting. If leaves and twigs or other jungle litter are beneath the breast of the bird, they are pressed down and form the sole lining; if not, the mold alone receives the pressure and is gradually rounded into a shallow form.

Egg: A single egg is laid at one time and incubated. Six eggs have been collected from as many nests generally distributed in the Kartabo research area, and these show weights, dimensions and stages of incubation as follows:

30	grams	.....47	×	34.5 mm.	Four day embryo
29	"	.....45.5	×	34.8 "	Fresh
34	"	.....51.2	×	36.1 "	Two day embryo
31.3	"	.....49.5	×	36 "	Full-grown embryo
29.5	"	.....45.5	×	35 "	Seven day embryo
34.2	"	.....50.7	×	36.7 "	Fresh

There is perfect correlation between weight and dimension, but, as is evident from the following table, there is no relation between weight and incubation:

<i>Weights</i>		<i>Average of length and width</i>		<i>Incubation</i>
29	grams	.....40.1	mm.....	Fresh
29.5	"	.....40.2	"	Seven day embryo
30	"	.....40.7	"	Four day embryo
31.3	"	.....42.7	"	Full-grown embryo
34	"	.....43.6	"	Two day embryo
34.2	"	.....43.7	"	Fresh

1	1	1
2	2	5
3	3	4
4	4	6
5	5	3
6	6	2

The extreme weights are 29 and 34.2; average 31.3 grams.

The extreme dimensions occur in the two fresh eggs, 47 by 34.5 and 50.7 by 36.7, the average being 48.2 by 35.5, or compounded 41.8 mm.

There is little variation in the color, the surface showing an exquisitely delicate tint which is but poorly expressed in our English



Fig. 19. Nest and egg of the Variegated Tinamou *Crypturus variegatus variegatus* (Gmelin).

term of light purple-vinaceous. There are sometimes zones of lighter tint about the larger or smaller end, due to some physiological cause in the lower portion of the oviduct. I consider the color of *Crypturus* eggs as distinctly protective, much more so than those of *Tinamus* whose turquoise sheen is readily seen against the jungle debris. As such it is at least one ameliorative factor in the risk of the small number, and the danger of the continuously breeding male bird. The birds always sit close, however, and only when almost stepped on, do they boom up and away. Many an egg would go undetected if instead the sitting tinamou would creep stealthily off at the first hint of danger. The gloss of the egg is not quite as high as in *Tinamus*, but it is still far ahead of any other bird's egg with which I am familiar,—one of the most beautiful shells in the world.

Out of the observation area I have known three eggs of the Variegated Tinamou to disappear suddenly long before incubation was completed, but only in one case do I know the cause, when a herd of peccaries trod heavily over the nest and all the neighborhood, a few fragments of yolk-stained shell showing how a single crunch had provided some wild pig with a delicious mouthful.

I have taken a fully-formed, but white and glossless egg from a bird more than half-way down the oviduct, so the pigment and gloss must be added very far down, just before the egg is laid.

Young: Incubation lasts about twenty-one days, and I have two notes, one of my own and the other by an assistant, of nests being deserted twelve hours and twenty-four hours after hatching. The parent therefore has at least the precocity of his offspring to lighten his labors. We have secured two young birds of about two and five weeks respectively, feeding by themselves at a distance from the parent, so the precocity extends to the independent juvenile life, thus allowing the male to take up, unhampered, a new round of domestic duties.

Relation to man: The Indians know the Variegated Tinamou as Orri-orri, and shoot it for food. As to hunting, the account to come under *Tinamus* holds, word for word, for this species as well.

EXTERNAL CHARACTERS

Weight: Adult Variegated Tinamous weigh from 345 to 393.5 grams; or $\frac{3}{4}$ to $\frac{6}{7}$ of a pound. Males vary from 345 to 374 grams; females from 356 to 393.5 with an average of 352 and 372 respectively, giving the dominant sex an excess of almost ten per cent.

Dimensions	<i>Males</i>	<i>Aver.</i>	<i>Females</i>	<i>Aver.</i>	
Total length . . .	291. -325.	310.7	310. -331.	323.	4%
Culmen	28. - 31.	29.8	29.5- 32.	30.7	3%
Width of nostrils	5.5- 6.2	5.9	5.5- 7.	6.4	8%
Eye diameter . .	8.5- 9.3	8.9	8.4- 9.4	8.9	—
Wing	155. -170.2	161.	159. -174.2	165.5	3%
Tail	45. - 50.	47.6	39. - 50.3	47.7	—
Tarsus	42. - 47.	43.8	44. - 48.	45.6	4%
Middle toe only	24. - 27.5	25.3	25.2- 26.8	25.5	—
Extent	515. -540.	529.5	536. -551.	546.	3%

For a sex dominant in courtship, female tinamou exhibit remarkably little specialization of secondary sexual characters; with plumage hardly to be differentiated, the birds show greatest differentiation in weight (10 per cent). In six body characters the females show an average excess of a fraction over four per cent, being equal in eye diameter, tail and length of middle toe.

Fleshy colors: There is little or no variation in the sexes in these colors. Beak, the upper mandible and the cutting edge of the lower are black; terminal half of lower, dusky; remainder of lower, cream buff. Eyelids, citrine drab. Iris, dark chestnut. Legs and feet citrine drab; claws on middle toes somewhat lighter.

Face and eyelids: In the full-sized young bird there are more feathers around the eye than in the fully adult. At first there are two complete rows, while in older birds these are reduced to a short row of about nine to ten minute feathers above and a short double row below.

Oil gland: Low, dark, spreading, truncate, anteriorly superficially divided by a slight crease; with two tufts of down on the summit, or occasionally four in the fully adult, the latter number arranged in the form of a square.

Claws: The thumb is without a claw in the adult; the index finger has a well-developed one, sometimes unworn and curved, or again worn down to a rounded nodule.

Wing graph: The wing is short and much rounded, with a deep inferior concavity; the outline of the primaries in the spread wing forms more than half a circle, while the corresponding outline of the secondaries is a very shallow segment of a circle. There are ten primaries, the outermost or 10th being considerably less than one-half the length of the 9th. A rather unusual condition exists at the

juncture of the two main series of flights; the 11th flight feather, in size, curvature, shape, pattern and follicle isolation is a true secondary, yet in actual position it arises quite distinctly from the head of the metacarpal and not from the ulna. I have chosen, however, to consider it as the 1st secondary which has been carried over the basal limits of this series. There are twelve secondaries, followed by three more feathers in the same linear series, but which are so soft and of such small size that they can take no part in actual flight.

Immature plumage: A two-thirds adult bird, weighing 303 grams, has the top of the head like the adult, except that it is dead black without a greyish cast; short feathers behind the eye and a few on the nape have pale-buff, subterminal, lateral spots; chestnut of the neck and upper mantle are much duller than in the adult. The dorsal contour and upper wing coverts are about one quarter juvenile, and three-quarters post-juvenile. On the dorsal body the juvenile feathers are pale, dull Saccardo's umber. In the last juvenile feather to come in there is a small, central subterminal black spot, below which is a touch of cinnamon buff; the first adumbration of the adult colors. This color is interesting as being an exact shade of darker, more generalized color than cinnamon buff (Ridgway's Color Standards, Plate XXIX, 15" d and 17" k). In the post-juvenile plumage the spot has expanded into a broad, wedge-shaped, subterminal band, wholly bounded by cinnamon buff, the tips of the barbs black. The latest appearing feathers, still partly ensheathed, show the three adult cinnamon buff bands dull but fairly well developed. In the post-juvenile moult the lengthened lower back and rump feathers are developed. On the juvenile tail-coverts, which in this plumage exceed the tail in length, the umber is here so extensive that it encloses a very broad band of the basal block.

The corresponding plumage on a fully adult bird shows the wedge-shape lost, the markings having become straight cross bands, and the feathers themselves much wider and more truncate. There are two solid bands of golden cinnamon buff and distinct traces of a third, all separated by wider bands of black, the distal one being terminal.

The ventral plumage in the immature bird is much more juvenile in pattern than the upper. The breast shows only a sprinkling of adult, self-colored cinnamon feathers, the present plumage exhibiting the juvenile, subterminal, elongated black patch, with the large, rounded, central, terminal white spot. On the lower breast the black

disappears, the white widens to a band, and the basal cinnamon fades until on the abdomen the feathers become pure white. On the sides there is a mingling of pectoral and dorsal patterns, resulting in many combinations of spots and bands, black, cinnamon, buff and white.

On the greatly elongated femoral wing, which is wholly distinct from the lengthened dorsal plumage, the basal color is dull cinnamon brown, with a wide, terminal band of white, bordered by an irregular, dark clouding. This tract extends from the front of the femur quite to the lateral rectrices, and the feathers are 40 mm. in length; they curve around between the thighs and the tail, meeting in midline, tips on, and covering all but the longest under tail-coverts.

The under tail-coverts, are, as in the adult, the most brilliant of the whole plumage, but strangely enough, they are even more conspicuous than in the adult, and when all in position, form very closely defined zones of color. The smallest, basal, anterior feathers are rich chestnut with a wide border all around of creamy buff and an arrow-shaped center of deep black; the following several rows of larger feathers are clear vinaceous buff; the last, largest row is parti-colored, considerably longer than the juvenile rectrices, with worn tips, showing how they have been functioning as tail feathers. Those on each side have the outer webs mostly chestnut, farther in, the black-center-buff-edged type prevails, while the central pair are almost wholly buff.

The juvenile rectrices are ten in number, the longest 41 mm.; the visible areas dull chestnut, mottled with black. Moults begins with the outer pair, the post-juveniles being almost clear black, with two, wavy but complete transverse bands of golden cinnamon buff, and more or less distinct traces of a third.

This two-thirds grown bird shows four nodes of moult in the wings. There are ten primaries, eight secondaries, and six tertiaries. The outermost, 10th, short primary is just losing the last basal sheaths of its long delayed growth; the innermost, or 1st primary, together with the 2nd and 3rd are new and full-grown, the latter still with blood at the base; 4th four-fifths grown, 5th a one-inch blood sheath, 6th to 10th old; 1st to 5th secondaries old, 6th just shed, 7th small blood sheath, 8th four-fifths grown; 1st tertiary half-inch sheath, 2nd to 6th old. Thus we see four moults, in the 10th primary, 1st primary, 8th secondary and 1st tertiary, the two distal being centrifugal, the two distal centripetal.



Fig. 20. *Crypturus variegatus variegatus* (Gmelin). Female in the position of courtship.
From a color drawing by Helen Damrosch Tee-Van.

Juvenile primaries have a faint, outer, terminal edge of russet and in the next moult this is reduced to a single subterminal notch of pale buff; the second post-juvenile moult sees the disappearance of this spot, and the primaries immaculately adult. In the juvenile plumage, the only difference in the feathers from the 6th tertiary to the 3rd secondary, is a gradual reduction of the russet on the tips and outer webs, correlated with the amount of exposed surface in the closed wing and a thin line of white along the outer web of the outer secondaries. In the innermost tertiary this russet covers half the entire feather, while in the 3rd secondary it is reduced to a broad, mottled, outer margin. The new secondary moult beginning with the 8th, marks a radical change to the adult, where the feather is wholly blackish brown except for clear-cut mottling along the outer third and a subterminal band of pale golden buff, reaching almost to the rhachis.

Comparison of the relative dimensions of birds in juvenile plumage with those fully adult, reveals some interesting facts. Such a comparison is as follows, with the ratio of percentage of the young birds:

	<i>Juvenile</i>	<i>Adult</i>	
Length.....	244.	310.7.....	78 per cent.
Culmen.....	24.5.....	29.8.....	82 “ “
Eye diameter.....	8.	8.9.....	90 “ “
Wing.....	142.	161.	88 “ “
Tail.....	40.5.....	47.6.....	83 “ “
Tarsus.....	41.5.....	43.8.....	94 “ “
Middle toe.....	24.5.....	25.3.....	97 “ “
Extent.....	465.	529.5.....	87 “ “
Weight.....	241.	359.5.....	67 “ “

The significance of these figures is apparent when we rearrange them in the numerical order of percentage values. First, and nearest to the adult is the toe length, 97 per cent.; the organs which of all others are of most importance in avoiding danger and seeking food. Closely following and directly connected with the toes is the tarsus, 94 per cent., while the eye, 90 per cent., deserves its high place as the second most important vital organ in the life of these birds. The wing, 88 per cent., comes next and it and its necessary corollary, the extent, 87 per cent., are the chief secondary line of defense when escape by foot is impossible. The tail, 83 per cent.,

is of less vital need, and the beak, 82 per cent., functions as well whether it is a few millimetres shorter or longer. The total length 78 per cent. is of no dominant importance in viability, nor is the weight, 67 per cent. Taken all in all, this table of statistics becomes really vitally significant when we interpret it in terms of the actual life of the organism.

Scalation: *Front*; Twelve to fourteen scales, the uppermost split in two, above this a group of faintly marked scales. *Inner*; Acrotarsium 30, 50, 50, 50, 30, planta tarsi about 20, between these are several rows of irregular diamond and hexagonal shaped scales. *Back*; Many small, irregular, hexagonal pavement scales on upper half of heel, from middle of heel to base of tarsus, ten to twelve scales, lowermost divided into two. *Outer*; Similar to inner, but often with less of acrotarsium, and more of planta tarsi visible.

Adult plumage: Crown of head and nape, black, paling to slate grey on sides of head, crown, forehead and lores. Ear coverts blackish brown; chin and throat, white; neck, dorsal and sides, chestnut; neck below, tawny, shading into cinnamon on mid-breast, and cinnamon buff on lower breast, many of the feathers faintly ringed with both hues. Mantle, back, wing-coverts and tail and sides of body, black, barred on mantle and back with a sub-terminal and terminal bar of golden cinnamon buff, the terminal bar changing to pinkish buff on the wing-coverts, longer tail-coverts and sides of body, and into greyish white on the flanks. Under tail-coverts variable, russet toward the base, followed by more or less black and tipped with pinkish buff.

Alula feathers along front edge of wing, primary coverts, primaries and secondaries, blackish brown; secondaries barely edged with pinkish buff on the proximal outer edge of outer web. Lower breast merges posteriorly into pinkish buff and on middle abdomen to greyish white. Tail feathers, neutral grey, with faint irregular terminal mottlings of russet and black.

Powder downs: In this *Crypturus* these tracts are dorsal and paired, consisting of two elongated patches down each side of the back, beginning 15 mm. back of the tips of the scapulars and ending at the antero-lateral base of the oil gland; each patch is a dense growth of long, greyish-white down, 15 mm. wide in front, narrowing to eight posteriorly, and 70 mm. in total length. These feathers penetrate the skin more deeply than the bases of the contour plumage, and lie almost flat, arranged in seventeen lines, a double row of feathers in each line.

Aftershaft: This structure is well developed on the contour plumage, the length averaging more than half the total length of the feather.

Parasites: Like all animals of the jungle floor, these birds suffer considerably from the attacks of *bête rouge*, those ever-present, larval *Thrombidium*, which attach themselves in great numbers to the more inaccessible portions of the body, such as the lores, ear openings and especially the rear crown and nape. The feathers here are sometimes quite worn away, or their follicles destroyed by the dermal irritation set up by the masses of mites. A tick is occasionally found clinging to the aural aperture, but these creatures offer little inconvenience.

Mallophaga are moderately abundant, but always present. On one individual I have found an elongated species, with spade-shaped head, and a series of lateral, brown sclerites which do not meet across the abdomen; together with another species, a broad-bodied, reddish-bordered insect, with large head, with wide and backwardly-directed horns. The latter are about ten times as abundant as the former.

Nematodes of two small species are present in almost all tinamou, while tape-worms are much rarer. I have taken one of the latter, one hundred millimetres long, with one hundred and fifty segments, from an immature female bird.

INTERNAL CHARACTERS.

Pecten: 2 mm. high; 6.5 long at base, 3 mm. at summit; twenty-three folds. Eye-ball 16.5 mm. in diameter.

Palate: Palatine fissure very far back; no denticulations on palate; the fissure has narrow, parallel sides for the anterior three-fourths of its length, expanding posteriorly.

Tongue and glottis: The tongue is very simple, triangular, with the longest arm in front, blunt, fleshy, posterior cornua with a gentle curve along the posterior side; tongue length 8, width 7 mm.; mandible length 53, width 17 mm. Glottis immediately behind the tongue, a well-developed epiglottid fold intervening; the opening long and parallel-sided, with rounded ends, no denticulation.

In a half-grown bird the tongue has much terminal pigment; the dimensions are length 7.5 mm. by 5 mm. broad. Faint lines along the posterior edge of the tongue and around the glottis may indicate vestiges of buccal teeth.

Syrinx: Extrinsic muscles arise at the 18th tracheal ring, where they close at once across the entire trachea, forming a nearly opaque sheath of muscle which extends quite to the larynx, slightly thinning as it goes; the fibres of one side of the overlapping extrinsics are usually dominant and overlaid upon the other; usually the left-hand ascending fibres overlie those of the right, before merging in the general longitudinal sheath. The free part of the extrinsic is about 25 mm. in length, very broad, 3 mm. in width, and curves around the lateral portion of the trachea as a curved sheath; farther on it narrows to 2.5 mm. in width and continues as a very thin ribbon-like muscle to its attachment on the sternum. Posteriorly almost all the fibres of the extrinsics extend on up the sides of the trachea, the extension across the centre being much thinner than in front.

The intrinsics are absent; posteriorly a very thin transparent, silvery, tendonous sheath extends down the centre of the trachea, covering more than half its width from the juncture of extrinsics to the syringeal collar; it here divides and is continued down the bronchi to the lung tissue, hence it may be considered as a second pair of extrinsic muscles.

Underlying this tendonous tissue is a very thin layer of muscular fibres, which increase slightly in density on the syrinx proper, but are wholly insufficient to manipulate the internal vocal pads. This posterior layer does not extend down the bronchi, but exhibits an abrupt attachment at the 1st tracheal ring, and passes in a solid sheet on to the oesophagus.

The tracheal length from the larynx to the 1st tracheal ring is 105 mm. Just back of the glottis the trachea is enlarged, but after a short distance the calibre rapidly becomes smaller, remaining so as far as the insertion of the extrinsic muscles. Here it again enlarges into an elongated cartilage box extending to the syrinx proper. The diameter behind the glottis 5 mm., midway down the neck 3.3 mm., largest diameter of the cartilage box 4.4 mm. The trachea is round throughout except for the box which is slightly compressed.

There are 125 to 130 rings from the larynx to the 1st tracheal ring. These are moderately wide and even-edged, with very rarely any traces of median thinning. Usually they are of the same calibre throughout, averaging half a millimetre in breadth, and they lie close together, separated when contracted, by an eighth to a third

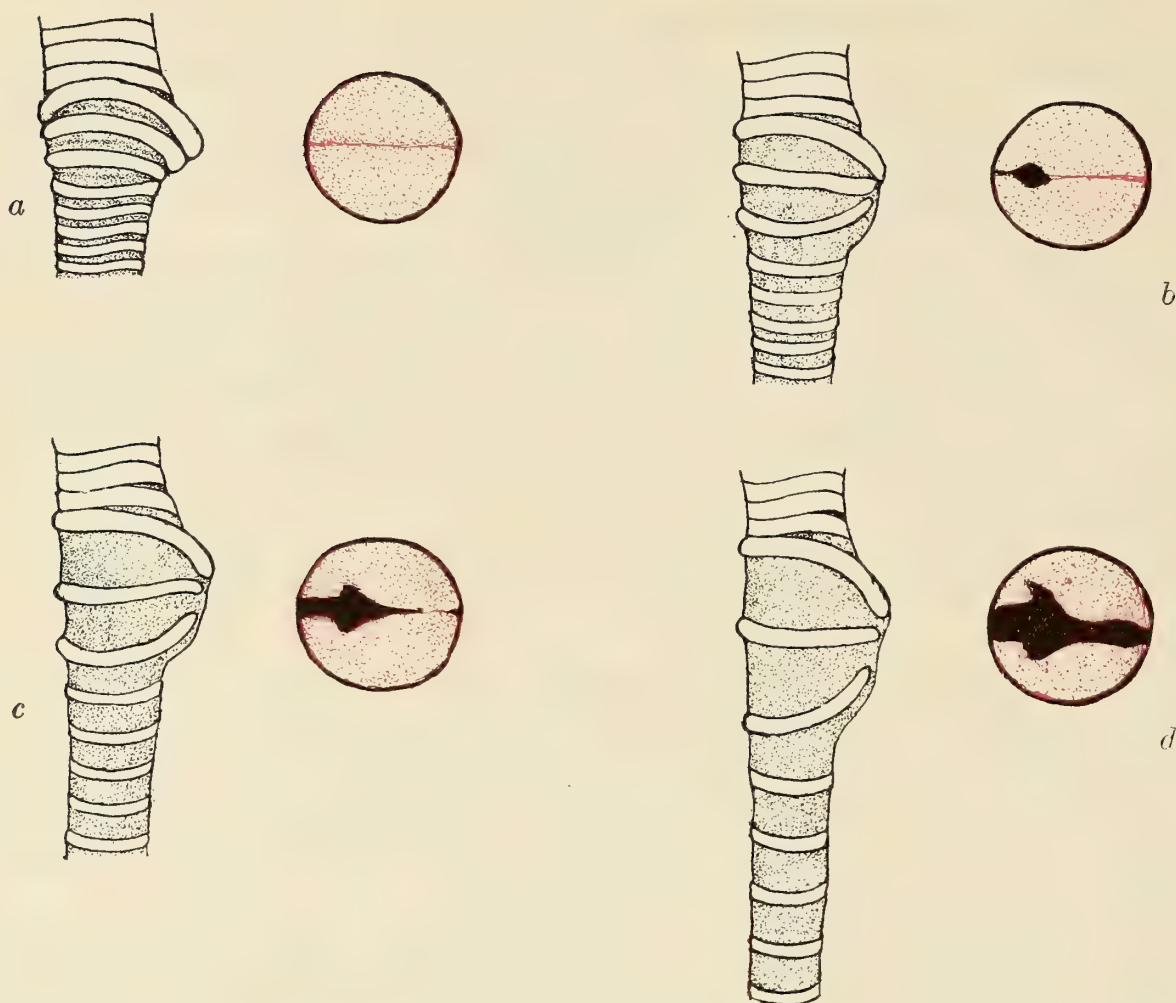


Fig. 21. Syrinx and cross-section of the bronchi of *Crypturus variegatus variegatus* (Gmelin). When the aperture is widest, the lowest note is produced. The gradual variation of the aperture is shown in *a*, *b*, *c*, *d*.

of their width of membrane, and when stretched, being only half their width apart.

The first change in character is at the level of insertion of the extrinsic muscles. From here the diameter increases and then decreases again to the syrinx, so that the trachea here assumes a slightly swollen, bulbous appearance, with an increase at the greatest diameter of almost 50 per cent. This diameter is reduced to 4 mm. at the upper neck of the syringeal collar. Another change is the still greater reduction of inter-annular membrane, so that this is practically, as I have said, a cartilaginous box, with extremely little mobility. An interesting thing is the frequent presence of numerous angular granules of dark pigment scattered along the fine membrane joints of this box, often extending on to the syrinx proper and even over the extrinsic muscles.

This specialized area begins about the 20th tracheal ring. At the level of its greatest diameter, the 7th ring shows a very slight downward bend anteriorly, and this increases rapidly in the succeeding rings, the sides maintaining their narrow calibre. In the 4th and 3rd rings, there are wide, triangular, downward projections in front, while the 2nd and 1st rings become again equal in breadth throughout. This last ring has a very steep downward slope and forms the arch of the bronchi.

The anterior ends of the 1st bronchial semi-rings articulate at the arch with the apex of the 1st tracheal ring, and in fact are closely connected with that ring throughout; in the relaxed, unstretched trachea the 2nd pair of semi-rings also concentrate at the arch and extend slightly obliquely upward from that point; the anterior ends of the 3rd semi-ring in their turn, lie as closely as possible to the arch, and extend out nearly horizontally. In the fully stretched syrinx the 2nd semi-rings are the horizontal ones, resulting in a considerable extent of membrane between these and the 1st semi-rings. The 3rd pair of semi-rings, in this extended condition, shows a very strong, downward curve at the sides, the anterior ends reaching up with their elongated tips toward the arch. There are thus two very wide expanses of membrane between the first three pairs of semi-rings.

The first four pairs of semi-rings are seen in their most normal relationship only in the fresh, relaxed syrinx. They are rounded and rod-like, in pronounced contrast with the flattened rings above, and semi-rings below, and are much longer than the neighboring rings, projecting considerably in front, often with a diameter of a third greater than the antero-posterior diameter of the tracheal box above. The anterior bellying is due to the projecting and overlapping ends of the first three pairs of semi-rings. There are sixteen undifferentiated semi-rings ending in the lung tissue, making twenty altogether.

Posteriorly, the structure of the syrinx is quite as simple as in front. The 1st tracheal ring and often the 2nd is broken. These, together with the ends of the 1st and 2nd semi-rings, are, as in front, all rather concentrated toward the bronchial arch, lying in two parallel rows in a sort of elongated, median groove which, were it a single sheet of membrane, might be called a bronchidesmus.

The exact method of voice production in this bird, is, I believe, unknown, and as long as only alcoholic specimens were available

there was slight chance of its being demonstrated. Acting on my accidental discovery, in the case of *Ibycter americanus*, of the possibility of reproduction of the whole vocal gamut by manipulation of a decapitated specimen, I attempted a similar feat with *Crypturus*. With four individuals I had no results whatever, and my efforts with the fifth were half-hearted, but met with instant success. Holding the bird on its back, and seizing the neck firmly, I stretched it to full extent and struck a sharp blow on the side of the breast muscles. At the second attempt I obtained a clear, high note, which if prolonged, would correspond exactly to the first long-drawn-out note of the bird's call. I repeated this several times, and then by slightly relaxing the tension I extracted a higher note, and so on until nothing but a shrill hiss of air came through the almost closed syrinx. This mechanical stretching and contraction of the respiratory organs followed the natural movement of the bird's neck when it was calling, the head and neck being drawn slightly downward as its notes rise successively higher in the scale.

The physiological method of voice production is seen clearly if the trachea be amputated just above the syrinx, and the latter held upright under a low-power lens. With a forceps grip at the edge of the trachea and another on the lowermost semi-ring of one of the bronchi, we may approach closely to a realization of the *modus operandi* of vocality. To reverse the sequence of tones, if I allow the structure to shrink together by its own weight, and then look directly downward, the bronchus is seen to be completely closed. A barely distinguishable seam extends straight across the center of the lumen. At a slight pull on the trachea, a tiny rounded opening appears in the seam, considerably nearer the posterior aspect of the syrinx; another pull and this widens, extending as a broad, open band quite to the posterior rim, and tapering anteriorly to a point more than half-way across the bronchus. The area of the original rounded opening opens out laterally into two flange-like windows. Again a tug, which takes up almost all the slack, and the vocal slit extends across the entire diameter, the lateral projections having become wider, almost wing-like. The plate (Fig. 21, *a*, *b*, *c*, and *d*) demonstrates these four phases far better than any mere description. No matter how little or much stretching tension is applied, only the syrinx and bronchi are affected; the tracheal box being quite immobile from the 1st tracheal ring upward.

There are two large cartilaginous cushions or partitions on each

side of each bronchus, the separation of which medianly is brought about by the extension of the syrinx and bronchial tubes. The most careful examination of this internal tissue reveals no trace of muscular fibre, only very soft elastic cartilage, of exactly the right mobility and elasticity to separate and close at the will of the external muscles.

A longitudinal section of the syrinx and upper bronchus shows that the lateral wing-like extensions in the partially open bronchus are due to a contracted area in the cartilage at that point. Even in the closed condition this division is very conspicuous on the inferior profile, and in this we have a clue as to the actual production of these lateral openings. The cartilages are thick and rounded, while on the outer and inner walls this tissue extends, as a gradually thinning sheet, down the bronchus. When the bronchus is stretched, these tracts are drawn down, the rounded, constricted syringeal cartilages are somewhat rotated inward, toward one another, and the ventral constriction, also rotating inward, produces a mutual gap, rounded at first, and extending more and more laterally as the stretching tension and rotation are increased. There is no marked difference either in the analogy or homology of this phenomenon in juvenile and adult tinamous.

Syringeal Variation: I have described an average, normal syrinx, but examination of several dozen of this species reveals a number of individual variations, showing that there is a slight latitude in the architecture of the organ which produces very similar sounds.²

A progressive tendency due to age is an increased ossification of the lower tracheal rings, both in front and behind. In the juvenile syrinx of two individuals the 1st tracheal ring was not quite connected anteriorly, making it actually in these isolated cases, the 1st semi-ring; posteriorly in three young birds the lowermost three tracheal rings were all broken, while in one juvenile bird, four tracheal rings were broken behind. As a rule in the adult the 1st tracheal ring is complete anteriorly and posteriorly the 1st and 2nd tracheal rings are broken. In old birds the 1st tracheal and the 1st semi-rings may be united by an osseous bridge across the anterior centre, rarely with a foramen in the middle, or, as in two extremely old females, the 1st bronchial, and the 1st and 2nd tracheal rings may be solidly fused in front, while posteriorly, very rarely, even the 1st tracheal ring may be solid.

² See page 216 for variation in the voice of *Crypturus*.

Visceral anatomy: described from adult female, W. B. Coll. Vert. No. 591. The flesh is pale greyish-green in color.

The crop is large, about 15 mm. in diameter when partly filled, and lying in the inter-furcular hollow; liver large, capping the gizzard, the lobes somewhat unequal, the left the larger, 24 mm. long, the right being 29; the left sends down internally a 10 mm. lobe, lying on the gizzard, while the projection of the right lobe is narrower but slightly larger, and applied to the side of the gizzard. The proventriculus is 25 mm. long and 11 in diameter. The gizzard is large and its anterior edge is turned slightly toward the right, dimensions 36 long by 34 deep by 22 wide. The lining of the proventriculus is loose and about to be shed, thin, white, and filled with large, vacuole-like glandular pits; the gizzard lining is also ready for sloughing; it is dark brown, rough, with numerous irregular cracks and pits, much like the bark of a chestnut tree.

The small intestine has an average diameter of 5 mm. and the remarkable length of 1030 mm. ($40\frac{1}{2}$ in.); the large intestine is 10 mm. in diameter and 85 mm. ($3\frac{1}{3}$ in.) in length; the caeca are extremely large, elongated lobes, constricted at the neck and increasing in girth to the extremity; they are 5 to 15 mm. in diameter and 75 in length. The large intestine and caeca are darker in color than the small intestine.

Heart moderate in size, 17 mm. long by 14 wide.

Chick of *Crypturus variegatus*.

On June 9th, 1922 a single egg of the Variegated Tinamou (set number 234⁰/₁) was taken from a nest on the ground in the jungle in S₁₇. It was light purple-vinaceous with the usual highly polished surface, weighing 33 grams, and with the dimensions 47.3 by 35.6 mm. As well as I could determine through the dense pigmentation, the embryo was five or six days old. The egg was placed in the incubator in a temperature of 100 to 103 degrees and dampened and turned regularly.

Sixteen days later, on June 25th, the egg was pipped at ten o'clock in the morning. Two hours later the chick was out, partially dried and creeping about all over the shelf. It was a male, as was ascertained later, weighed 16 grams, and the two pieces of egg-shell weighed 2 grams. A very considerable residue remained in the small end of the shell and weighed 2 grams more. Compared with *Tinamus major* these weights are as follows:

	<i>Tinamus</i>	<i>Crypturus</i>	
Egg.....	53	33	62 per cent.
Chick.....	38	16	42 “ “
Shell.....	5	2	40 “ “
Adult.....	1133	362	32 “ “

The shell was broken by direct outward pressure of the egg-tooth at twelve distinct places around a very straight line, exactly 10 mm. or one-fifth of the total distance from the large end.

The dimensions of the one day chick compared with the average of twenty-eight adult males are as follows:

	<i>One day Chick</i>	<i>Adult Male</i>	<i>Chick's Dimensions</i>
Total length.....	103	310.7	33 per cent.
Culmen.....	12.5	29.8	42 “ “
Width at nostrils.....	3.4	5.9	57 “ “
Eye diameter.....	5.8	8.9	65 “ “
Wing.....	23.5	161	14.5 “ “
Tail.....	20	47.6	42 “ “
Tarsus.....	19.5	43.8	44 “ “
Middle toe only.....	16	25.3	63 “ “
Extent.....	90	529.5	17 “ “

The most significant fact in this table is that the three dimensions in which the chick reached more than 50 per cent. (width of bill 57 per cent., eye diameter 65 per cent. and middle toe 63 per cent.) are of organs of apprehension, of sight and of speed, the three most necessary qualities in the life of the newly hatched chick.

The beak is pinkish grey, shading to fuscous on nostril tube, gape and tip; the bare portion of the lower eyelid is light purplish grey, the very narrow fleshy eye rim dull olive brown; iris dark hazel; legs and feet yellowish buff touched with pink, heels and sole pads dark purplish grey, tips of toes and upper half of claws grey, claws cream color.

There are numerous, small, golden, tawny down feathers around the eye, a single row in front, increasing to three or four at the back; the upper lid is densely feathered with normal head down, upper half of lower lid bare, lower half fairly densely covered with bristly tipped down.

Oil gland conspicuous, flat-topped, deeply bisected, surmounted

with three tufts of down, dark and slender at base, fluffy and pale buffy at the tips. There are small but perfectly distinct claws on the pollux, and large, well-developed, subterminal blunt ones on the index fingers.

The egg-tooth is low, not very sharp, and at the extreme tip of the upper mandible. It spreads out into a large, flat base, extending one-sixth of the total length of the culmen. It is an ideal pressing tool, the pressure force being distributed over a large surface of the soft beak.

The position of the chick in the egg is also very obviously an adaptation to facilitate shell breaking. The neck and head are folded close to the breast and abdomen, while the right leg is raised far forward and sideways until the beak rests directly on the under side of the flexed tarsus. Pressure is thus brought to bear on the shell not only by movements of the head but the slightest effort at extension of the leg and foot automatically forces the beak in general and the egg-tooth in particular against the inner wall of the egg-shell.

A very deep lateral groove begins near the tip of the maxilla and extends back to the nasal fossa. The nostrils are large, with a light-colored operculum covering half of the deep opening, and extending back into a conspicuous, swollen tube, directed slightly upward.

A very deep groove on the mandible pinches off the swollen median portion extending along the gonys quite to the rami, corresponding in size and position to the area shut off by the groove on the maxilla.

In the wing of the newly hatched chick, five primaries are already so far developed that the prenatal down is supported on their tips well above the skin. On the morning of the third day when the chick died, these feathers showed very considerable additional growth. There are in all nine primaries visible. The outermost or 10th is well developed but short, the next five are very long, and the inner three are short. The average length of the five long ones is 6.3 mm., of the four short primaries 3.6. The 1st primary is not distinguishable except as down, and the same is true of all the secondaries.

A typical mid-dorsal down is 18 mm. long, and consists of about twenty barbs, which are simple and spring mostly from the basal sheath, although a main shaft is distinguishable, with several shorter side barbs. The barbules are long and very fine and silky, and of

equal length throughout, dying out abruptly and leaving a long bare tip. They are greyish white at base, black throughout the middle length, and suddenly and strongly tawny red on the last distal barbules and the long terminal shaft.

The tail down is surprisingly long, both in front of the oil gland on the lower rump, and behind it where the future rectrices will appear. In fact a semi-circle of sixteen or twenty large down curved along the tail area are unusually strong, and may be twenty-three mm. long, the tips curved conspicuously around and down, giving the chick an appearance unlike any other young bird. This tail down is decidedly dendritic, with only six or eight barbs arising basally, the others branching from a thick main shaft, which only near the summit trivariates into barbs equal in size to the others. The barbules differ from those of the dorsal down in being shorter, farther apart, standing out from the barbs at wider angles, and also in giving the appearance of a radial rather than a bilateral arrangement. The whole down is solid russet in color.

The Scallation resembles that of the adult as regards the larger scales of the acrotarsium and plantar tarsi, but the outer and inner aspects are much simpler, with far fewer scales than in the old tinamou. Front: fourteen scales, the top three broken into two or three; inner: acrotarsium 40, 40, 50, 50, 60, and 20 per cent., plantar tarsi 50, 50, 40, 40, 30, and 30 per cent., the narrow slit between forming a simple out-bent fold of skin; back: twelve plantar tarsi scales, beginning on heel, lowermost split into three, nine hexagonal, irregular scales down inner side, which might be considered as a scale row of the inner aspect; outer: 10, 40, 50, 50, 50, 50, and 60 per cent., plantar tarsi 20, 20, 20, 20, 10 per cent., the remaining surface covered with two, or for a short distance three, rows of small hexagonal scales.

Plumage: The chick of *Crypturus variegatus* is much more brilliantly colored than that of *Tinamus major* and the body pattern is simpler. Taken as a whole, the colors are curiously reversed, the dark chestnut back color of *Crypturus* being ventral and lateral in *Tinamus*, and the golden tawny of *Crypturus*' breast being found on the back of the larger chick.

The forehead of *Crypturus* back almost to midcrown, a broad band over the eye and back to the nape, together with the facial down, tawny olive, becoming lighter and more silvery well back of the eye. The basal half of the loreal down is black, giving this area

a dark appearance. At the posterior corner of the eye a narrow band of bay extends backward over the ear-coverts, widening on the side hind neck and merging with the dorsal color. This is bordered narrowly with black. The crown and upper nape are bay, except for a median spot and a narrow irregular line of tawny olive which begins on the mid-crown, well behind the forehead color, and extends medianly back to the hind neck. The entire upper and lateral body down is uniform bay or dark chestnut, reaching well down in front of the wings, including the lesser wing-covert down and the more dorsal elongated tail down. It is separated laterally from the ventral colors by a well-marked line of black. The chin and throat are whitish, becoming ochraceous tawny on the breast, lower sides, flanks and thighs. The side breast is deeper tawny and the abdomen paler buff. The greater mass of tail down is russet. The greater wing-covert down is ochraceous tawny, the sprouting quills blue-black.

Biology of *Crypturus* Chick: The chick pipped the shell at ten in the morning and, as I have already related, was out and partly dried at noon. The down dried well except on the back and head, until I put in a circular band of flannel, into which the chick crept and by rubbing around as it would under its parent's plumage, the dorsal down dried fluffily. There is no doubt that the young bird would never dry well without the constant friction of the old bird's feathers during the first twelve hours after hatching. This condition of the down is apparently a rather serious thing, for when the down dries flat and matted together, it causes such irritation that the little chick wastes much time and strength in trying to preen the bad places. Even a slight thing like this might very well be a matter of life and death, at a time when every moment of learning to correlate eye and beak is of the utmost importance.

I observed that the banging of the incubator door caused instant fear reaction—the chick squatting at once, but no other observations were made until the following day at ten in the morning when it was taken into the compound in a vivarium.

Placed on the ground the *Crypturus* chick twice showed fear reactions, and then perched of its own accord. I worked with it off and on all day, and at last it took four small pieces of worms. On the whole it was far less apt in learning to calculate distances than *Tinamus major* of equal age. This was so marked that I believe it to be another example of very delicate balance between necessity



Fig. 22. Three day chicks of *Crypturus variegatus variegatus* (Gmelin). Lateral and dorsal views, natural size. From a color drawing by Isabel Cooper.

and practice. In *Tinamus* there is a single adult to look after a brood of six to ten, while the solitary *Crypturus* chick has the whole attention of its parent, so there is far less need for extreme precocity in this case than in the former. With only a single chick to look after, greater care will be taken, and more time devoted to feeding and guiding the offspring. In *Tinamus* the young are compelled to forage more on their own, having the disadvantage of only a fraction of parental solicitude.

Another characteristic peculiar to this species in comparison with *Tinamus* is its relative silence. The other chicks, or even one by itself, were always cheeping or calling, whereas this one utters only very low calls and at infrequent intervals. Even these are given only when the bird is quiet and undisturbed, and seem to be more of the nature of content calls than otherwise. It is readily seen that it is important for a covey of chicks to keep in touch with one another by frequent calls, whereas a single chick following its parent could with safety do so in comparative silence.

The *Crypturus* chick learned the use of its legs and by two P.M. could make its quick, short spurts without falling over at the end. It never walked slowly more than a step or two, but usually after several futile pecks at the bit of worm which I proffered, if it heard a sudden noise, it darted swiftly away for one or two feet and squatted flat. I tested it with various sounds and found that I could cry out loudly, or clap my hands together near it without effect, but the least deep or hollow sound, such as striking the glass side of the empty vivarium, caused it to jump and flatten. Its pecking, as in *Tinamus*, was always forward and downward at the ground, and its constant fault was to strike beyond the object aimed at. The chick was uncomfortable on a white handkerchief and scuttled to bare ground as quickly as possible. It pecked at worms and spiders much more readily on the ground, even when they were of the same color as their surroundings, than when they were laid conspicuously on light bamboo leaves or when held in the forceps.

I tried calls and whistles with no apparent effect, until I imitated the note of *Crypturus* itself. Like a flash the chick turned in my direction, ran six feet toward me, and crouched beside my foot. I tried it again and again, then summoned the members of my staff to watch. The shrillest whistle brought no response, but the very first note on G sharp above middle C, attracted and held the little

bird's attention, and the following notes brought it headlong. After such a reaction it was much more alert and willing to attempt another bit of food, and not only this, but its sense of direction was all but perfect. When I held my face close to the ground and called, the chick ran, not only toward me, but stopped at my mouth, although I had finished calling before it reached me.

This instinctive and perfect reaction to the call of the species, together with its disregard of the call of *Tinamus* and other terrestrial jungle birds, was wholly unexpected. I have known chicks of other groups to crouch instinctively at the cry of a hawk, or the alarm note of their own or other birds, but to recognize among many other imitations, the exact summons call was very interesting, and threw a new light on the instinct reactions of this very generalized type of bird.

It did not enjoy being in the hot sun, but ran with quick darts toward the shade. Like the other tinamou chicks it never showed the slightest fear of our, to it, enormously tall figures stalking about. In fact, if anyone passed while I was attempting to induce it to eat, it invariably rushed off and followed them and had to be brought back and started over again in food interest. Unlike the *Tinamus* chicks no shuffling of hands or feet in scratching motions and sounds had any effect.

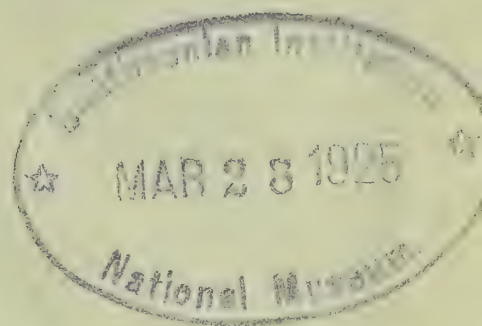
Like so many of the small creatures I have watched in the laboratory compound, the chick persisted invariably in working toward the east or north-east. Again and again I turned it about and always it changed direction and started back. I place no special significance at present upon this, but present it as an interesting fact, as applying to mammals, birds, reptiles, amphibians and even to armored catfish. When, however, I gave the parent's call, the chick never failed to turn and run toward me, regardless of direction.

While it learned to peck and swallow bits of food and quartz with fair accuracy, I could not give it the constant attention and encouragement which it needed, and it died on the third day.

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THE MEMBRACIDAE OF KARTABO BARTICA DISTRICT, BRITISH GUIANA

WITH DESCRIPTIONS OF NEW SPECIES AND
BIONOMICAL NOTES

By Maud D. Haviland (Mrs. H. H. Brindley)
Lately Fellow of Newnham College, Cambridge

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THE MEMBRACIDAE OF KARTABO*

Through an oversight, printer's proofs of my paper, "The Membracidae of Kartabo" (Zoologica, Vol. VI, No. 3—March 1925) were not submitted to me, before publication, and in consequence a number of errors appear in the text. I therefore avail myself of this opportunity to make the corrections which follow under Errata, and also to include a note on a point of nomenclature which came to my knowledge after the despatch of the manuscript.

[MAUD D. HAVILAND]
(Mrs. H. H. Brindley)

Note.—Professor J. Graham Kerr, F.R.S. has directed attention to a number of Fabricius' types in the Hunterian Collection at Glasgow; (*The Glasgow Naturalist*, Vol. II, No. 4, 1910) and he has kindly enabled me to examine them. The collection includes two specimens of *Enchenopa* (*Campylenchia*) *nutans*, Germ. labelled *Membracis hastata*.

As this species is described in the *Mantissa Insectorum*, 1787, and Germar, who does not allude to Fabricius' species, described *Enchenopa nutans* in 1821 (*Mag. der Ent.*, IV, p. 28) Fabricius' name claims priority over that of Germar.

ERRATA

Page 231, et seq	For Haviland-Brindley, read Haviland
" 236, " "	" <i>Tropidocyta</i> , read <i>Tropidoscyta</i>
" 248, line 31	Read "Not uncommon; resembles <i>T. cimicoides</i> in habits"
" 249, " 15	For 909, read 1909
" 249, " 19	" gnats, read ants
" 249, " 36	" metopodium, read metopidium
" 255, et seq.	" <i>Polyglytodes</i> , read <i>Polyglyptodes</i>
" 255, footnote	" Kinkaldy, read Kirkaldy
" 257, et seq.	" <i>Telemona spiniger</i> , read <i>Telemona spinigera</i>
" 258, " "	" <i>Stegaspis laevipennis</i> , Fairm., read <i>Lycoderes laevipennis</i> , Fairm.
" 261, line 41	" Condate, read Cordate
" 261,	nov. nom., read nom. nov.
" 262, line 4	" <i>scutellus</i> , read <i>scutellatus</i>
" 262, " 20	" had, read has
" 262, " 22	" <i>Lophyraspis</i> , read <i>Lophyraspis</i>
" 267, " 15	" insonspicuous, read inconspicuous
" 269, heading	" Havildand, read Haviland
" 273, line 33	" <i>Aphetae</i> , read <i>Aphetea</i>
" 275, " 29	" <i>spinigena</i> , read <i>spinigera</i>
" 276, " 2	" <i>monocercus</i> , read <i>monoceros</i>
" 277, " 11	" <i>Stictocephala</i> , read <i>Stictopelia</i>
" 279, " 3	" <i>Cyphonia</i> , read <i>Cyphonia</i>
" 279, paragraph 3	and 4 should run on
" 282, line 8	For <i>Cephonia</i> , read <i>Cyphonia</i>
" 281, " 33	" <i>Aphetes</i> , read <i>Aphetea</i>
" 287, " 26	" <i>Leiocyta</i> , read <i>Leioscyta</i>
" 288, " 29	" <i>guianensis</i> , read <i>guianae</i>
" 290, " 15	" highest, read lowest
" 290, " 16	" crests, read crest

* Zoologica, Volume VI. No. 3.

THE MEMBRACIDAE OF KARTABO¹ BARTICA DISTRICT, BRITISH GUIANA.

WITH DESCRIPTIONS OF NEW SPECIES AND
BIONOMICAL NOTES.

BY MAUD D. HAVILAND (MRS. H. H. BRINDLEY).

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(Fig. 23; Plates I–VI incl.)

OUTLINE.

INTRODUCTION

LIST OF SPECIES

GEOGRAPHICAL DISTRIBUTION

LIFE-HISTORIES AND HABITS

ATTENDANCE BY ANTS

ENEMIES

FIELD OBSERVATIONS ON FORM AND COLOUR

THE NYMPHAL FORMS

KEY

INTRODUCTION.

In 1922, by the courtesy of the Director, Mr. William Beebe, I spent five months at the Tropical Research Station of the New York Zoological Society at Kartabo, on the Mazaruni River, in British Guiana, and during that time, I made some studies of the Membracidae of the district.

The collecting area, which was confined chiefly to a distance of two miles inland from Kartabo Point, included cassava plantations and clearings, mangrove swamp and forest. Most of the forms described here were taken by myself; but a few species, previously obtained at the Station, have been included. These are marked in the following pages with an asterisk. The determination of certain examples presented difficulties, as the types of the older writers were not always available, and I have been obliged sometimes to rely upon the identifications of others in the collections of the British Museum and of Oxford.

The types of the new species described here are in the British Museum of Natural History.

¹ Contribution, Department of Tropical Research No. 192.

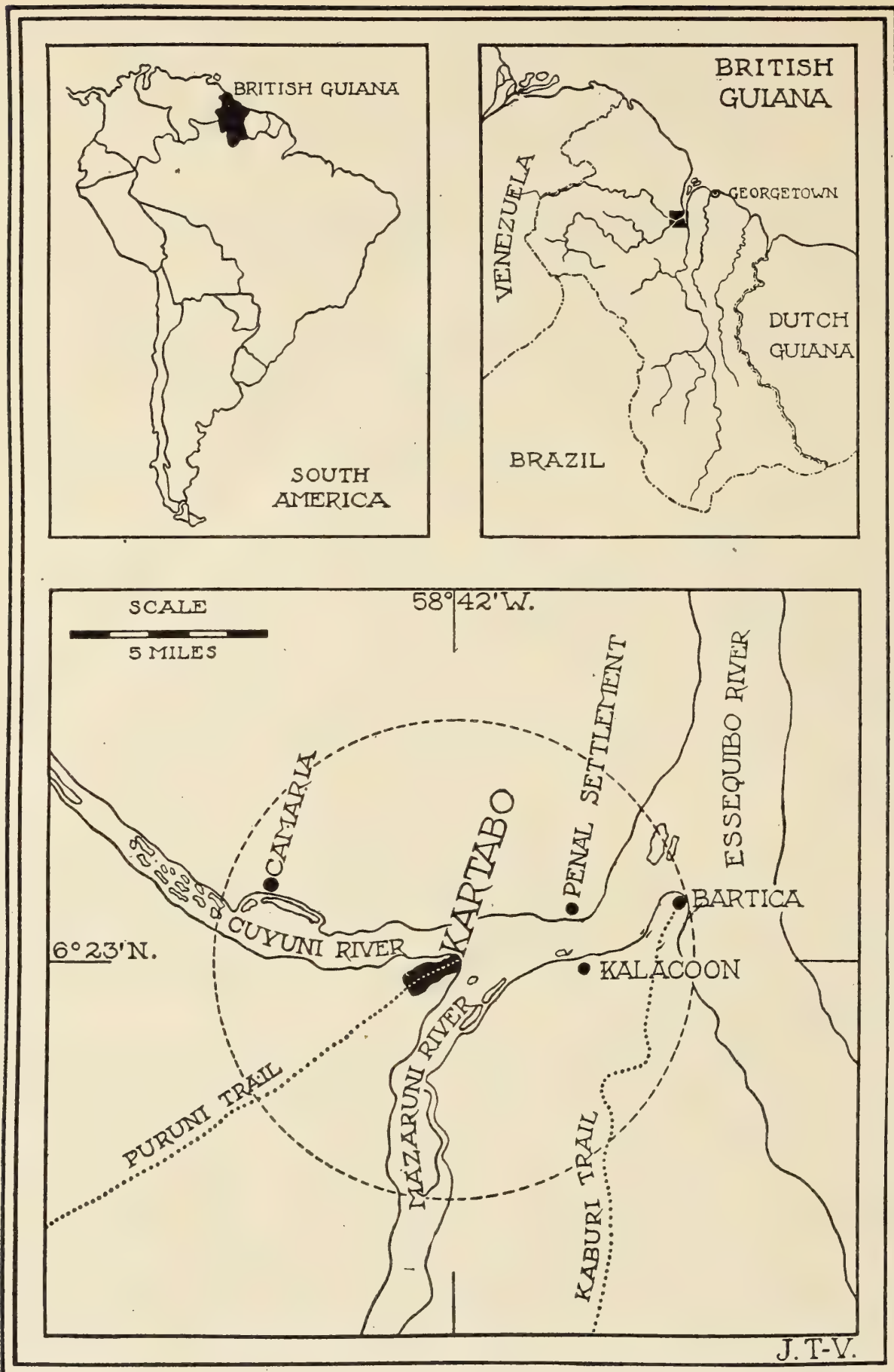


Plate A. British Guiana Tropical Research Station of the New York Zoological Society.
Circle represents a radius of six miles.

The synonymy of each species makes no pretension to completeness, but indicates merely where an earlier description can be found.

My thanks are especially due to the Royal Society for a grant enabling me to visit South America; to the authorities of Newnham College for leave of absence during the last three months tenure of my Fellowship; and to Mr. William Beebe for permission to work at the Station, and for much kindness during my stay there.

I must also express my obligations to Mr. Funkhouser of the University of Kentucky, who has examined many specimens for me and compared them with the types of neotropical *Membracidae* in his collection; and to Dr. Hugh Scott of the University of Cambridge (England) who has given me much valuable assistance on taxonomical points while writing this paper.

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LIST OF SPECIES

Found at Kartabo Point, Bartica District,
British Guiana

Membracis arcuata (Oliv.).

Membracis arcuata, Fairmaire, *Ann. Soc. Ent. Fr.*, 2, IV, p. 247, 1846.

In the nymphal stages, this species is gregarious, and resembles *M. tectigera*, *M. c-album*, etc. The adult is often solitary, and is rather sedentary, feeding on the young shoots of low shrubs in light trails and clearings.

Membracis c-album Fairm.

Membracis c-album, Fairmaire, *Ann. Soc. Ent. Fr.*, 2, IV, p. 244, 1846.

(Pl. VI, fig. 9, nymph.)

This species appeared from time to time between June and September, and is apparently gregarious at all stages. Colonies of the adults and mealy white nymphs occur on the twigs of trees and shrubs of various kinds in open places. The adults are rather sluggish, and when disturbed soon return to their original position.

Membracis carinata (Fabr.).

Membracis carinata, Fairmaire, *Ann. Soc. Ent. Fr.*, 2, IV, p. 244, 1846.

One example (female) taken 6-IX-1922, on low foliage in an open place in the forest.



a



b

Fig. 23.—*a*, Colony of *Enchenopa lanceolata*; *b*, Nymphs of *Membracis tectigera* on *Vismia ferruginea*.

Membracis fasciata (Fabr.).

Membracis fasciata, Fairmaire, *Ann. Soc. Ent. Fr.*, 2, IV, p. 245, 1846.

One male, collected at the Station, 3-I-21.

Membracis fusca de Geer.

Membracis fusca, Fairmaire, *Ann. Soc. Ent. Fr.*, 2, IV, p. 244, 1846.

A few examples were taken early in June, in the middle of the rainy season, after which no more were obtained until September, when they appeared in numbers on a flowering tree which provided several other species of *Membracidae*. The form of the nymphs and general habits resemble those of *M. c-album*, and *M. tectigera*. There is considerable variation in size, but this does not appear to be altogether a sexual character.

Membracis humilis Fowler, var.

Membracis humilis, Fowler, *B.C.A., Homop.*, II, p. 6, 1909.

One female specimen (no date) collected at the Station. The white fascia on the metopidium is absent.

Membracis tectigera (Oliv.).

Membracis tectigera, Fairmaire, *Ann. Soc. Ent. Fr.*, 2, IV, p. 246, 1846.

Common from June to September on trees and shrubs in open places, and resembling *M. c-album* in its mealy young, and gregarious habits at all stages. One example was taken from the web of a spider. The males are considerably smaller than the females, but the latter vary a good deal in size, and many are not larger than the males. A variety taken at the Penal Settlement in 1917 is pale fawn colour, and lacks the white band on the metopidium.

Enchenopa albidorsa (Fairm.).

Enchenopa albidorsa, Walker, *List Homopt. Ins. Brit. Mus.*, p. 481, 1850.

Three females taken at the end of July, in the shade of the forest.

Enchenopa bifenestrata Funkh.

Enchenopa bifenestrata, Funkhouser, *Journ. N. Y. Ent. Soc.*, XXX, No. 1, p. 1, 1922.

(Pl. I, fig. 4, eggs. Pl. VI, fig. 2, nymph.)

I am indebted to Mr. Funkhouser for determining this species by comparison with his types.

It was a small, inconspicuous form, common on the twigs of *Vismia* and other woody plants in the clearings. The egg-cases are flat, brown, scale-like objects. (Pl. I, fig. 4.) Oviposition took from one to three days, and the female frequently remained seated upon the eggs after the process was completed. This species was social, and often occurred in company with *Tragopa* and *Horiola* spp., sharing with them the visits of ants.

Enchenopa lanceolata (Fabr.).

Enchenopa lanceolata, Walker, *List Homop. Ins. Brit. Mus.*, p. 481, 1850.

This species was common on the bank of the river near the Station, but seemed to be confined to one host plant, a herb of the order Scrophulaceae with

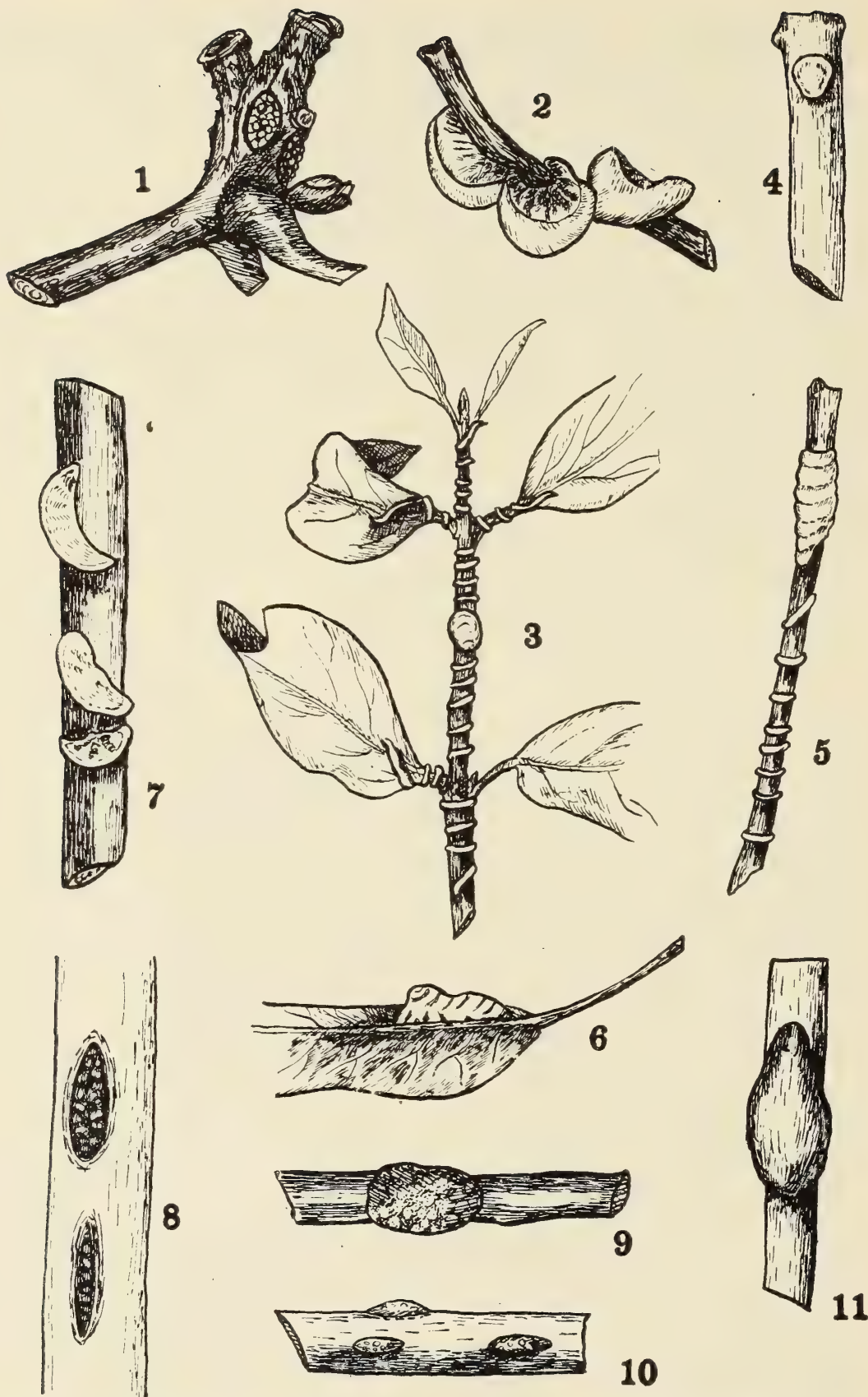


Plate I.—Egg-clusters of, 1, *Tropidocyta gibbosa*, de Geer.; 2, *T. bulbosa*; 3, *T. pruinosa*; 4, *Enchenopa bifenestrata*, Funkh.; 5, *Leioscyta spiralis*; 6, *Campylenchia nutans*, Germ.; 7, *Bolbonota aspidistrae*; 8, *Endoiastus productus*, Osborn; 9, *Aconophora compressa*, Walk.; 10, *Lophyraspis armata*; 11, *Aethalion reticulata*, Linn.

large, greenish-white flowers. The eggs of the Membracids were laid in masses of twenty to twenty-five together in punctures in the epidermis of the stem, and were covered externally with a glistening, white deposit of froth-like wax. The adults did not remain upon the eggs, as is the habit of *Enchenopa bifenestrata* and others of the genus. The eggs hatched in five to six days. The nymphs were white and mealy at every stage, unlike those of the northern form, *E. binotata* Say, which, according to Matusch (Journ. N. Y. Ent. Soc., XX, no. 1, 1912) lose the white coat after the second moult. They were plentifully attended by ants, in this respect again differing from the allied form (Funkhouser, Journ. Econ. Ent., 8, June, 1915). I made considerable collections and records of the development of this species, but my observations as to the number and form of the different instars agree so nearly with what has been written by the authors just cited that it is unnecessary to include them here. The duration of the nymphal stages is discussed elsewhere in a more general connection. The last ecdysis is very striking. The skin splits longitudinally along the dorsum, and the perfect insect, soft and pale, creeps out, leaving the moulted skin attached to the stem by the fore-legs. At first the anterior and posterior processes of the pronotum are equal in size, their axes lying parallel to the long axes of the body; but within seven to ten minutes, literally under one's eyes, the frontal horn elongates, erects itself, and takes on the distinctive form and curvature of the adult, although it requires another two hours or so for the chitin to become black and hard.

Enchenopa monoceros (Germ.).

Enchenopa monoceros, Amyot et Serville, *Hemip. Hist. Nat. Ins.*, p. 535, 1843.

Four females taken together on the flowering twigs of a leguminaceous tree in a clearing, August 8, 1922.

These examples vary considerably in depth of colour.

Enchenopa pulchella Funkh.

Enchenopa pulchella Funkhouser, *Journ. N. Y. Ent. Soc.*, No. 1, p. 2, 1922.

Four examples taken in August, all obtained by sweeping in the low herbage of a cassava clearing near the Station.

One of these (female) has the pronotum unicolorous golden orange, with a black-edged dorsal carina.

Campylenchia nutans (Germ.).

Enchenopa (*Campylenchia*) *nutans*, Fowler, *B.C.A., Homopt.*, II, p. 12, 1909.

(Pl. I, fig. 6, eggs. Pl. VI, fig. 3, nymph.)

This form was taken sparingly in June, on a small straggling tree with reddish bark which was common in clearings near the Station. The egg-masses, on which the females remained seated, were elliptical waxy bodies, deposited on twigs and on the under sides of leaves. The species was attended by ants. The horn varies considerably in size and curvature, but this is not apparently a sexual character. The nymphs are a bright chestnut brown, furnished on the dorsum with two pairs of long, black, divergent spines. The extremity of the

anal tube is provided with a pair of even longer spines, which project outwards at right angles to the long axis of the body. I can throw no light on the function of these curious appendages.

***Tropidocyta bulbosa*, sp. nov.**

(Pl. I, fig. 2, Pl. II, fig. 3, Pl. VI, fig. 8.)

Head sooty brown, clothed with thick yellow pubescence, much longer than wide; margins of genae foliaceous; clypeus spatulate, margin somewhat foliaceous, rounded at the apex; eyes brown; ocelli yellow, small, nearer to each other than to eyes, and situated on a level with the upper margins of the eyes.

Pronotum pitchy brown, thickly covered with yellow pubescence; convex in front, not produced into an eminence or horn; humeral angles sub-triangular, blunt; a transverse sulcus above each eye; median carina strongly percurrent; on either side a well-marked lateral ridge extends from the apex of the metopidium over the shoulders to the middle of the posterior process where it terminates in a shallow depression, and another slight depression lies behind the shoulders; posterior process acute, tectiform, not reaching to the tip of abdomen.

Tegmina opaque, brown, sub-hyaline at the apex; veins brown, broad and very hirsute; three discoidal cells.

Underparts and legs pitchy brown; hind tibiae strongly spined; tarsi yellow. Long. 3.0 mm. Lat. 1.75 mm.

Type: Female. Sexes alike.

This species is allied to *T. minuta* Funkh., but Mr. Funkhouser, who has compared examples from Kartabo with the types in his possession, considers it distinct.

T. bulbosa is a small, dark, globose insect, which in the field has the facies and habits of a Bolbonota. It was taken in June and July on foliage in the trails in company with *B. aspidistrae* and the eggs were found in July on the twigs of a flowering shrub in a clearing near the Station. The egg masses are of the same type as those of *B. aspidistrae*, but are thicker, whiter and more definitely cup-shaped.

Under the microscope, this nest is a beautiful object, and is very large for the size of the insect. The eggs, to the number of twelve to fifteen, lie in the plane of the long axis of the parent's body, and are arranged radially in a semi-circle. The colleterial secretion issues in the form of a lustrous white thread of waxy material, which is wound and piled around and over the eggs in an elaborate manner to form a cup in which the female sits, freely attended by ants. These egg-masses sometimes occur singly, but more often in clusters, and formed quite conspicuous objects against the dark bark.

Two females and a male of the series differ somewhat from the description given above, without meriting specific rank. They are smaller (Long. 2.5 mm.; Lat. 1.5 mm.) and darker in colour. The median carina is ferruginous, and an additional small carina extends over the shoulder. The tegmina are dark and less hairy than in the type form; the apical areas are clear hyaline, and there is a conspicuous clear spot at the apex of the clavus.

Tropidocyta gibbosa (de Geer).

Cicada gibbosa de Geer, *Mem. V.*, p. 211, 1775.

Membracis bicristata Fairmaire, *Ann. Soc. Ent. Fr.* 2, IV, p. 256, 1846.

Tropidocyta gibbosa, Stal, *K. Sven. Vet-Akad. Handl.* 8, p. 45, 1869.

? *Tropidocyta albipes* Funkhouser, *Journ. N. Y. Ent. Soc.*, XXX, no. 1, p. 4, 1922.

(Pl I, fig. 1, eggs.)

The figures and descriptions of de Geer and Fairmaire leave little doubt that this is the form whose synonymy is given above.

This species is of interest as being the only Membracid in the collection from Kartabo which invariably caused a definite local deformity of the host plant. It was found in August, in dark places in the forest, on a certain straggling shrub with waxy pink flowers which were borne in a loose inflorescence. While still in bud, this inflorescence was attacked by *T. gibbosa*. It became distorted and lignified; and the bud that it bore shrivelled and fell off. The eggs in masses of forty to fifty together were laid on this deformed stump. The adults and nymphs, attended by ants, clustered upon it and were never observed to feed on any other part of the plant.

***Tropidocyta neglecta*, sp. nov.**

(Pl. II, fig. 4.)

Head pitchy black, thickly beset with golden pubescence, longer than wide; margins of genae sinuate, acutely lobed at the apex; clypeus sub-triangular, foliaceous, projecting for more than half its length beyond genae; eyes brown; ocelli yellow, small, inconspicuous, twice as far from one another as from eyes, and situated on a level with the upper margins of the eyes.

Pronotum dark ferruginous brown, roughly sculptured, pubescent, not punctate, sub-angulate in front, not produced into a horn. Metopidium about as wide as high, furnished with a strong percurrent carina which is ferruginous brown, high and sharp; posterior process acuminate, somewhat compressed laterally at two points behind the middle, slightly depressed at the apex, not reaching tips of tegmina; on either side a strong lateral carina extends obliquely over the shoulder to the margin behind the base of the tegmen.

Tegmina brown, opaque, punctate at the base, paler at the apex; veins very pubescent; three discoidal cells.

Long. 4.5 mm. Lat. 2.0 mm.

Type: Female.

One example taken on *Vismia ferruginea* by sweeping, 2-IX-22.

***Tropidocyta pruinosa*, sp. nov.**

(Pl. I, fig. 3; Pl. II, fig. 5.)

Dark purplish brown, punctate; head, prothorax and underparts thickly clothed with silvery pubescence, which gives the insect a frosted bloom.

Head about as long as wide; margins of genae semi-foliaceous, lobed; clypeus foliaceous, broad and rounded at the apex, which projects considerably beyond

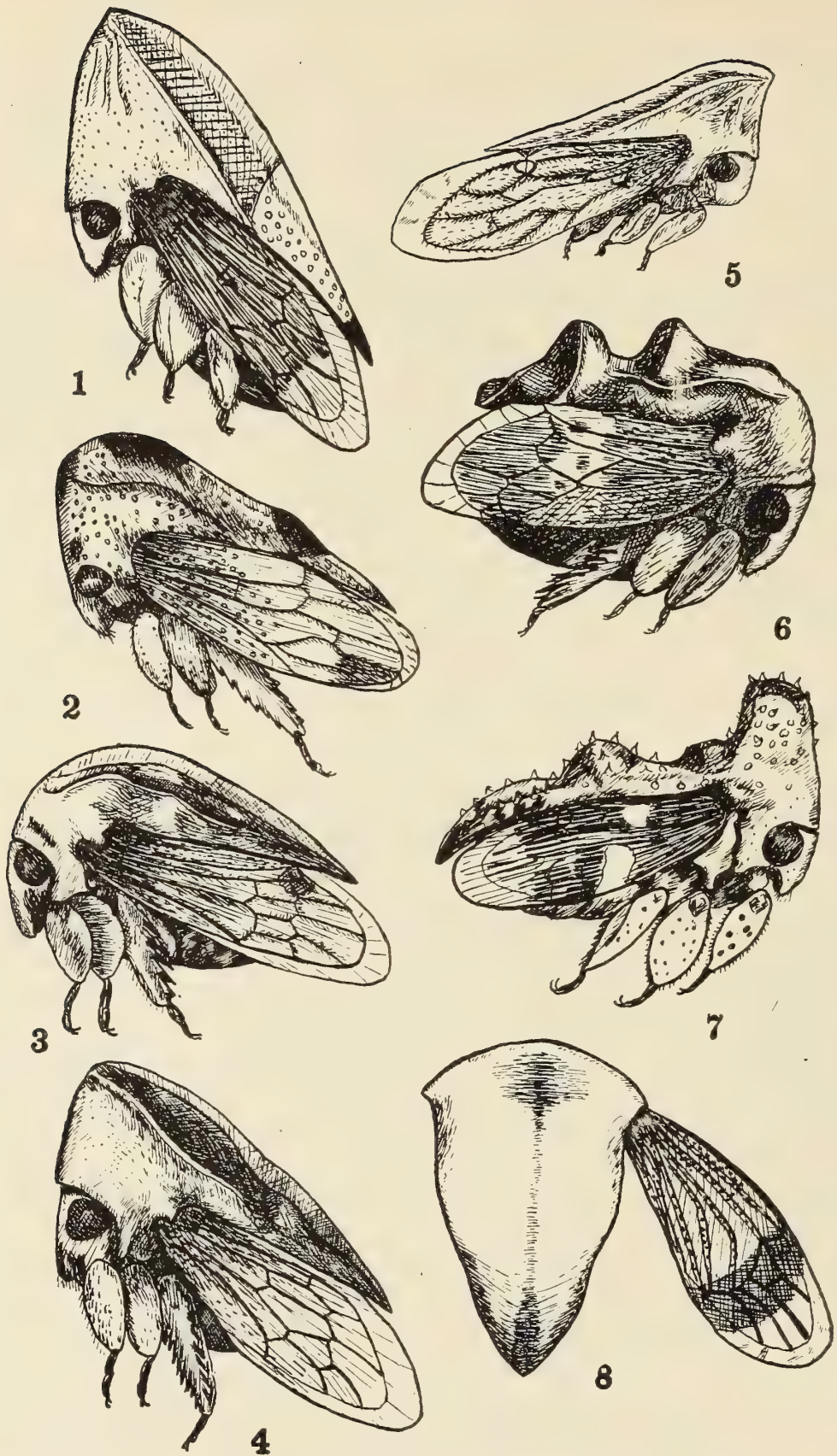


Plate II.—1, *Leioscyta beebei*; 2, *L. spiralis*; 3, *Tropidocyta bulbosa*; 4, *T. neglecta*; 5, *T. pruinosa*; 6, *Bolbonota aspidistrae*; 7, *Hypsoprora aspera*; 8, *Rhexia kartabensis*.

margins of genae; eyes yellowish grey, rather prominent; ocelli amber colored, nearer to the eyes than to the median line, and situated on a level with the centres of eyes.

Prothorax furnished with a very short, conical, blunt horn slightly recurved at the apex; anterior border straight; metopidium traversed by a faint, median ridge; humeral angles rounded, not prominent; posterior process narrow, acuminate, just reaching the tip of abdomen, and furnished with a sharp, per-current carina; a pair of lateral carinae on each side, the superior, which is sharp and strongly marked, extends from the tip of the frontal horn to the margin of the posterior process, half way to the apex, the inferior is less pronounced and extends from the metopidium to the humeral angles; edges of the carina black, the intervening spaces heavily clad with white pubescence; tegmina entirely free, brown, opaque, and with a velvety bloom; a small sub-hyaline spot at the base of the internal apical cell; veins very broad, raised, and together with the basal areas of the corium and clavus, clothed with white, silky hairs; one discoidal and five oblong, narrow, straight, apical areas.

Legs pale, sordid yellow; tibiae scarcely foliaceous, the hind pair furnished with row of spines; tarsi tipped with black.

Long. 5.4 mm.

Lat. 2.0 mm.

Tegmen: 5.0 mm.

Type: Female.

This species is very distinct. It has the facies of a *Tropidocyta*, and in spite of the non-foliaceous legs and the single discoidal cell, should probably be placed in this genus, for the venation is obscure, and as the description is based on a single example, the disappearance of a cross vein may be an individual abnormality.

This species was rare at Kartabo. In the beginning of June, my attention was attracted by white, spiral threads of some viscous or waxy substance, twined round the twigs of shrubs, five or six feet above the ground; but it was not until the 26th of the month that I recognized these as the unfinished nurseries of this Membracid. The thread is wound many times above and below the egg-case, which is a lenticular, glistening, white body, in which the eggs are embedded. The female sitting upon this egg-mass was not attended by ants. The purpose of the thread is not known. It may be a protection against predatory enemies, but after removal of the female, I kept the nest under observation for some time, and on the following day found that it was invaded by ants, although the thread was intact. The egg-case gradually disintegrated; only two nymphs were hatched, and these disappeared a day or two later.

The number of nests of this elaborate plan that were left uncompleted is striking; for early in July, I found two more, but neither searching nor sweeping produced another example of the Membracid.

***Leioscyta beebei*, sp. nov.**

(Pl. II, fig. I.)

Head ochreous, shaded with dark brown; margins of genae arcuate and acutely lobed below; clypeus lobed at its articulation with genae, and with the free margin foliaceous and broadly rounded; eyes grey; ocelli yellow, equidistant between the eyes and the median line, and situated just above the level of the centres of the eyes.

Pronotum testaceous yellow, punctured densely in front and more coarsely behind, obtusely angular, not horned at the frontal apex; metopidium high, perpendicular, furnished with a carina which is strong and percurrent on the dorsum; humeral angles not prominent; a strong lateral carina on either side extending from the metopidium to the pronotal margin half-way to the apex of the posterior process; three, faintly marked ridges on either side of the metopidium, below and in front of the lateral carina; posterior process acuminate, not quite reaching tip of abdomen, white, black at the apex, and furnished with a bright, chestnut spot on the dorsum between the lateral carinae.

Tegmina chocolate, with a yellow, sub-hyaline patch at the apex. Abdomen, underparts and legs ferruginous black; tarsi yellow.

Long. 5.0 mm.

Lat. 2.0 mm.

Tegmen: 4.25 mm.

Type: Female.

Sexes alike.

A male and female collected at the Station 29-X-20.

I have much pleasure in naming this species after Mr. William Beebe, Director of the Tropical Research Station at Kartabo.

***Leioscyta spiralis*, sp. nov.**

(Pl. I, fig. 5, Pl. II, fig. 2.)

Head ochreous brown, finely punctate, clothed with silky white pubescence, longer than wide; margins of genae foliaceous; clypeus foliaceous, rounded laterally, and with the apex truncate; eyes brown; ocelli yellow, rather large, nearer to the eyes than to one another, and situated on a level with the upper margins of the eyes. Pronotum sordid ochre, clouded with umber brown, paler behind, punctate, pubescent; metopidium carinate, sloping, rounded at the summit, not furnished with an eminence or horn; humeral angles sub-triangular, not produced; posterior process roughly sculptured, coarsely punctate, very acute, just reaching to the tip of the abdomen; median carina high, sharp, and percurrent; on either side, a strong curved lateral carina extending from the summit of the metopidium over the shoulders to the lateral margin of the posterior process, two large spots on the dorsum and the apex of the posterior process, chocolate brown.

Tegmina brown, coriaceous and opaque at the base, and with a dark spot at the apex; veins pale brown, broad and hirsute.

Underparts dark brown, pubescent; tibiae sordid yellow.

Long. 6.0 mm.

Lat. 3.5 mm.

Length of Tegmen: 6.0 mm.

Type: Female.

This species resembles the type of *Enchenopa quadricolor* Walk. in the British Museum, but differs in the stouter form and position and curve of the lateral carinae. This, the only example obtained, was taken from a curious egg-mass of the type of that of *Tropidocyta pruinosa*. The eggs themselves were embedded in an imbricated, brown, waxy mass, and the twig below was encircled about a dozen times with a white viscous thread. During the time that the nest was under observation, it was not visited by ants, but I found by experiment that the thread was no bar to these insects, which were running in numbers over the tree.

***Bolbonota aspidistrae*, sp. nov.**

(Pl. I, fig. 7, Pl. II, fig. 6, Pl. VI, fig. 1.)

Head black, with golden pubescence, much longer than wide; genae acutely lobed at the apex; clypeus foliaceous, lozenge-shaped, with angles sub-acute; base of head convex and rather prominent; eyes dark brown; ocelli translucent, twice as close to eyes as to each other, and situated on a level with upper margins of eyes.

Prothorax bronze black, pubescent, punctate, highest between shoulders, with humeral angles conical, blunt and prominent; dorsum furnished with two tubercles of equal size; the anterior conical, and not laterally extended; the posterior strongly carinated and extended transversely to the lateral margins of the pronotum. A percurrent, median carina extends over the metopidium and tubercles to the apex of the posterior process, which is sub-acute, roughly sculptured and not especially depressed. A strong, semicircular, lateral carina extends backwards from the metopidium on each side of the anterior tubercle.

This species is variable in colour. In some examples the whole insect is deep, sooty black, and the tegmina are black and opaque, occasionally spotted with white, and hyaline at the apex. In others, the genae and clypeus are bordered with ochreous; the prothorax and abdomen are ferruginous; the dorsum, including the carina, tubercles and apex, and the legs are ochreous yellow. In such a case the tegmina are ferruginous, marked conspicuously with white and yellow.

Long. 3.0 mm.

Lat. 2.0 mm.

Type: Female.

Sexes alike.

This species, like *B. corrugata*, *B. inaequalis* and *B. pictipennis*, was common in the more open, forest trails on the upper surface of leaves of *Aspidistra* and other plants. All these forms readily take wing, but are otherwise well protected, owing to their resemblance to small pieces of bark and withered buds which fall in profusion from the foliage overhead.

In July, I found a small colony breeding on a shrub beside a trail. The nests are crescentic, white structures, hollow above, and usually placed two or three together at the base of a petiole. The female sits in the concavity until the brood is hatched, unless accidentally disturbed, and if she departs, she does not find her way back again. The nymphs are dull green and active. Soon after hatching, they crawl up the stem and feed on the under side of the leaves on the mid-rib. The nesting females and nymphs are visited by swarms of ants, which muster to the attack if the plant is shaken, but the free-living adult Membracids, probably owing to their restless habits, are never thus attended.

A small series in the Hope Museum at Oxford is labelled in Canon Fowler's handwriting as *Tylopelta gibbifera* Stal. It is undoubtedly near to *B. aspidistrae*, from which it differs in its smaller, more elongate form, and in the less prominent humeral angles and carinae. I am unable to trace this species unless it is identical with *Tropidocyta gibbera* Stal. which Fowler (*B.C.A.*, p. 15) removed to his new genus *Tylopelta*, but it does not altogether correspond with the descriptions of that form.

Bolbonota corrugata Fowler.

Bolbonota corrugata Fowler, B.C.A., Homopt. II, p. 19, 1909.

Two examples among a series of *B. aspidistrae* obtained in the forest, June 26th, 1922.

Bolbonota inaequalis (Fabr.).

Bolbonota inaequalis, Fairmaire, Ann. Soc. Ent. Fr., 2, IV, p. 259, 1846.

Two females taken by sweeping in the forest, June 14th, 1922, and a third, and two nymphs of the last instar, obtained on a twig in rather a dark place in the forest, July 1st, 1922. The nymphs were covered with mealy white powder, and were attended by ants.

Bolbonota pictipennis Fairmaire.

Bolbonota pictipennis Fairmaire, Ann. Soc. Ent. Fr., 2, IV, p. 258, 1846.

One female taken by sweeping in the forest, Sept. 22nd, 1922, and determined by comparison with the series in the British Museum.

Pterygia uropygii Buckt.

Pterygia uropygii Buckton, Monograph of the Membracidae, p. 72, 1903.

One female was taken on leaves in the forest, July 24th, 1922.

This remarkable form is a very beautiful object under low power of the microscope, the spines along the dorsum and lateral horns being touched with purplish pink.

Stoll figures what is evidently meant for this species (Cic., fig. 8) under the title "Het Kruis," or "The Cross."

Sphongophorus guerini Fairmaire.

Sphongophorus guerini Fairmaire, Ann. Soc. Ent. Fr., 2, IV, p. 262, 1846.

This species was solitary, and not uncommon on shrubs and low foliage in the clearings. It was rather sluggish, and could easily be caught by hand. According to my observations, it was never attended by ants.

***Hypsoprora aspera*, sp. nov.**

(Pl. II, fig. 7.)

Head covered with white encrustation, punctured with black, rather longer than wide; margins of genae straight, acutely lobed at apices; clypeus extending far below genae, spatulate, with the free margin slightly rounded and pilose; eyes grey and prominent; ocelli grey, twice as far from each other as from eyes, and situated on a level with the upper margins of the eyes.

Prothorax rugose, black, profusely decorated with white, punctured and studded with small spines; furnished with a stout, erect, frontal horn, which is truncated, not compressed, and carinated at the apex; posterior process long, carinate, much compressed laterally, with the apex blunt and decurved, reaching the tips of the tegmina; dorsum provided with two tubercles, a small one at the base of the frontal horn, and a large, rounded protuberance behind it. On either side of the latter is a strong, lateral ridge, which extends to the apex of the posterior process.

Tegmina chocolate brown, black and punctate at the base and decorated with white patches on the claval and costal margins; venation somewhat obscured.

Abdomen and underparts black, decorated with white; femora and tarsi black; tibiae very foliaceous, white and punctate.

Long. 5.50 mm. Lat. 2.50 mm. Alt.: 3.50 mm.

Type: Female.

This form is very close to *Hypsoprora (Pterygia) pileata*, Fairm.

A single example was taken by sweeping in a clearing, July 23rd, 1922.

Aconophoroides gladiator (Walk.).

Aconophoroides gladiator, Fowler, B.C.A., *Homopt.*, II, p. 48, 1909.

This species seemed rather scarce at Kartabo. Three examples were taken at the beginning of June, and another male in September, in every case on the reddish bark of a shrub of species undetermined.

On one occasion a specimen had just been captured by a spider.

The horn of the male is much shorter than that of the female, and may be almost obsolete.

* *Umbonia spinosa* (Fabr.).

Umbonia spinosa, Fairmaire, *Ann. Soc. Ent. Fr.*, 2, IV, p. 276, 1846.

Four specimens taken at the Station, August 16th, 1922.

Darnis latior Fowler.

Darnis latior Fowler, B.C.A., *Homopt.*, II, p. 52, 1909.

Single individuals were found occasionally in the darker parts of the forest, feeding in the axils of the leaves of herbaceous plants.

Darnis partita Walk.

Darnis partita Walker, *Ins. Saunders.*, *Homopt.*, p. 75, 1850.

More common than the last, and fed in the axils of leaves, in lighter parts of the forest. Usually it occurred singly, but occasionally two individuals were found together.

Stictopelta indeterminata (Walk.).

Stictopelta indeterminata, Fowler, B.C.A., *Homopt.*, II, p. 59, 1909.

Three specimens collected at the Station, July 21st, 1922, evidently belong to this species, which, following Fowler, I have included in the genus *Stictopelta*. I am, however, inclined to think that it would be more properly placed in Fowler's own genus, *Hebeticoides*, for the distinguishing characteristics, the contiguity and position of the bifurcation of the ulnar veins, are variable even in the small series of examples that I have had for comparison.

Aconophora compressa Walk.

Aconophora compressa Walker, *List. Homopt. Ins. Brit. Mus.*, p. 541, 1850.

(Pl. I, fig. 9, eggs.)

Taken in July and later in August and September, on the stems of a shrub in a shady place. The adults readily take wing, but soon return to their original

position. The egg-cases are brown, elliptical bodies, each containing a score or more eggs, which are embedded in the waxy substance of the case and not inserted in the tissues of the plant. Each female remains seated on her eggs unless disturbed. The long frontal horn appears remarkably like a thorn or broken twig when the insect is seen thus *in situ*, and this character is also well marked in the nymphs. It is of course relatively little developed in the early instars, which are dingy ochreous and black forms; but already by the fourth instar the frontal horn and dorsum are conspicuously marked with bright, ferruginous brown, and the sides of the body are decorated with white, flocculent patches. The nymph of the fifth instar is much more gaily coloured than the adult. The head, wing-cases and underparts are black; the pronotum is bright chestnut, marked heavily along the sides with black, and with a black stripe down the carinated metopidium. The rest of the thorax and abdomen are black, conspicuously variegated with yellow and white, and the legs are black with yellow femora.

The nymphs of every stage are furnished with four pairs of long, black, dorsal spines; the first, on the mesonotum, are somewhat recurved, and project back on either side of the posterior process. The remaining pairs are on the first, second and third abdominal segments. At all stages the nymphs are active and run rapidly down the stem when disturbed. Their long, red-tipped horns give them the semblance of a row of thorns, although the plant on which they were found in this instance is not thorny. They excrete large quantities of "honey-dew," which smears the surrounding foliage, and attracts many ants.

Cymbomorpha vaginata (Germ.).

Cymbomorpha vaginata Stål; K. Sven. Vet-Akad. Handl. 8, 1, p. 34, 1869.

Two females, dated the 15th and 22nd of July, 1922. One had been carried off by a hunting spider.

***Rhexia kartabensis*, sp. nov.**

(Pl. II, fig. 8.)

Head pale green, shining, punctate, sub-triangular, broader than long; genae straight; clypeus small, rounded, hairy at apex, not produced beyond margins of genae; eyes red, prominent; ocelli yellow, twice as far from each other as from eyes, and situated on a level with the upper margins of eyes.

Pronotum pale translucent green, shining, very finely punctured, convex, highest above shoulders, non-carinate; metopidium sloping, twice as wide as high; humeral angles blunt, slightly produced; posterior process sub-acute, much compressed behind shoulders, margin sinuate, not quite reaching apex of tegmina; a dark brown median line from metopidium extending along dorsum; lateral margins and apex of posterior process much suffused with olive green.

Tegmina entirely free, yellowish brown, semi-opaque, with a broad dark band across the distal third and hyaline at the apex; veins pale brown, punctate.

Underparts green; legs yellow; hind tibiae with three rows of small black spines.

Long. 6.0 mm.

Lat. 4.0 mm.

Type: Female.

One example taken on foliage in a trail, attended by ants, Sept. 4th, 1922.

Heteronotus armatus Lap.

Heteronotus armatus Laporte, *Ann. Soc. Ent. Fr.*, 1, IV, p. 97, 1832.

(Pl. III, fig. 8.)

The Kartabo series has been identified by comparison with specimens determined by Fowler in the Hope Museum, and also with those in the British Museum. *H. confusus* Butl. is possibly a synonym; and Fairmaire is probably right in supposing that *H. spinosus* Lap. is only a pale form of *H. armatus*.

This fine insect was not uncommon round the Station in August and September, but the nymphs were not found. The adults were solitary, and inhabited the edges of clearings. They sat in full view on the upper side of the foliage, and readily took wing with a loud buzzing noise.

I procured examples of two other forms of this genus allied to *H. armatus*, but which do not correspond to any named specimens or descriptions of species to which I have access. Both were taken in the same surroundings, and have the same general facies and habits as *H. armatus*. It is probable that many of the described forms of this type will prove to be varieties of a single species. At present the difficulty of determining examples from brief descriptions, often unsupplemented by figures, is very great.

Heteronotus albospinosus, sp. nov.

(Pl. III, fig. 6.)

Head gamboge yellow with two black stripes. Prothorax armed anteriorly with two, long, slender, yellow spines, diverging outwards for the first half of their length and then curved almost to a right angle and directed backwards. Posterior process divided into three nodes or swellings, the first being the smallest, and the second and third nearly equal in size. The third, which is borne at the end of a peduncle equal in length to half the diameter of the node, is furnished with one ventral and two dorso-lateral, slender, backwardly-directed spines. Pronotum ochre yellow, bordered with cream colour. On either side of the metopidium, a black stripe, continuous with the facial stripe, extends obliquely to the lateral margin, where it joins a second black stripe rising behind the eye, and reaches the humeral angle; between the anterior spines, a circular black spot, interrupted by a median yellow line; second and third nodes laterally suffused with black. Spines wholly yellow, with the exception of the posterior dorso-lateral pair which are white for the distal third of their length.

Rest of body and limbs yellow. Tegmina hyaline yellow with black veins.

Length of body to end of abdomen 7.5 mm.

Length of body from frons to tip of posterior spines 10.0 mm.

Length of tegmen 8.0 mm.

Width between tips of anterior spines 5.3 mm.

Type: Female.

A specimen in the Hope Museum, collected by Bates on the Amazon in 1861, and labelled “? sp.” in Canon Fowler’s writing, belongs to this form.

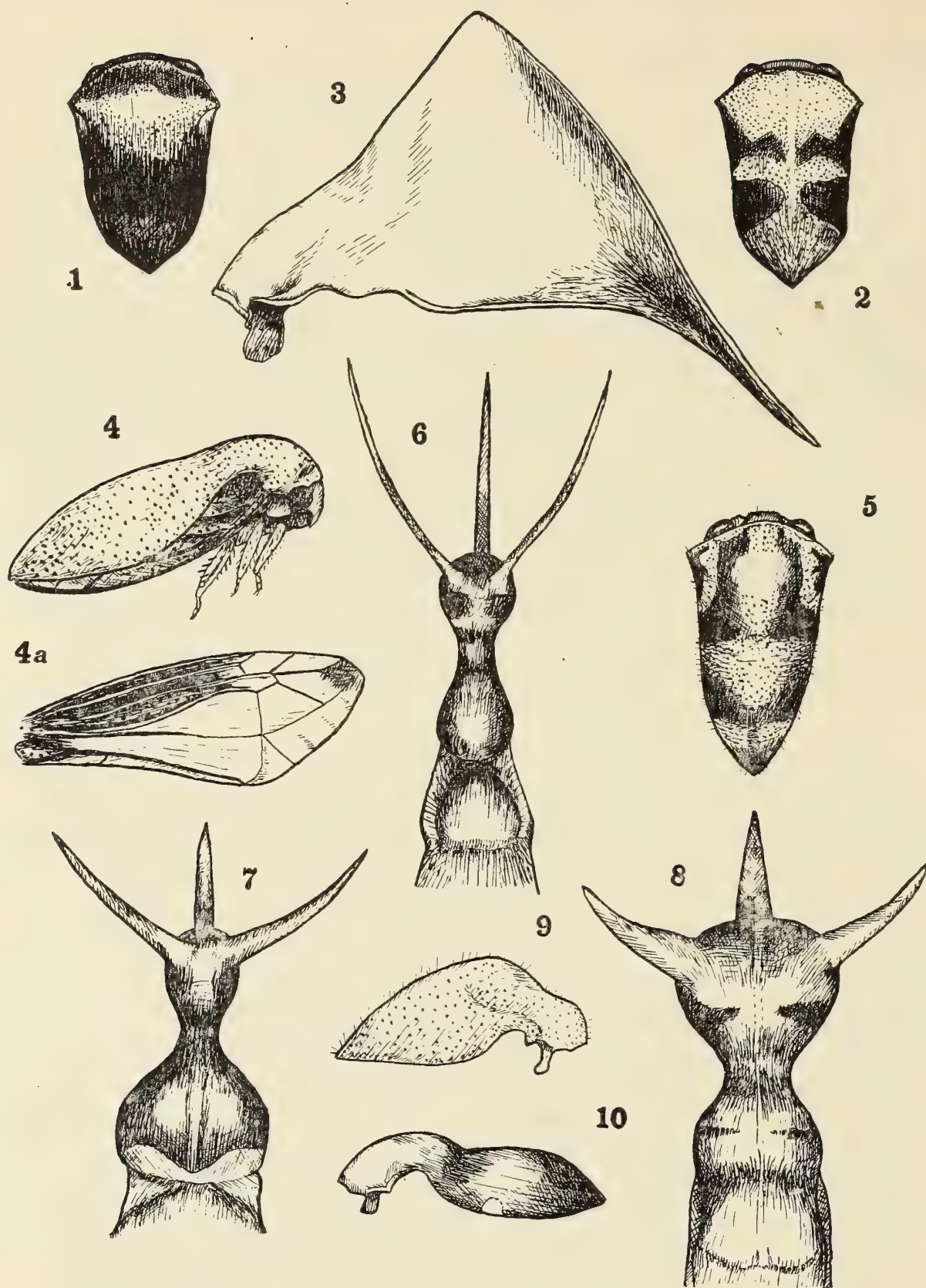


Plate III.—1, *Tragopa occulta*; 2, *T. guianae*; 3, *Telemona spinigera*, prothorax; 4, *Aphetes affinis*; 4a, *A. affinis*, tegmen; 5, *Vanduzee testudinea*; 6, *Heteronotus albospinosus*, posterior process; 7, *H. vespiformis*, posterior process; 8, *H. armatus*, Lap., posterior process; 9, *Amastris funkhouseri*, prothorax; 10, *Boethoos globosa*, prothorax.

***Heteronotus vespiformes*, sp. nov.**

(Pl. III, fig. 7.)

This form is close to *H. divisus*, Wlk., but the peduncle of the posterior node is somewhat differently constructed.

Head gamboge yellow with two black stripes.

Pronotum gamboge yellow, decorated with two, broad, black stripes, which are joined by a transverse band at the base of the posterior process, and are interrupted by a large, cuneiform, yellow spot on either side of the metopidium and by a circular, yellow area round the base of the anterior spines, which are black, stout, and directed slightly backwards. Posterior process ochre yellow, with a low tubercle at the base and two nodes; the first large, black, not constricted in front, rounded behind; the second smaller, oval, arising by a short peduncle not equal in length to half the width of the node, heavily marked with black and furnished with one ventral and two dorso-lateral, stout, almost straight and backwardly diverging spines.

Rest of body and legs yellow; tarsi black.

Tegmina yellowish hyaline, shining, with black basal, and brown apical, veins.

Length from frons to tip of abdomen..... 8.0 mm.

Length of tegmen..... 10.0 mm.

Length from frons to tip of posterior spines..... 10.0 mm.

Width between tips of anterior spines..... 6.0 mm.

Type: Female.

Tragopa cimicoides (Fabr.).

Tragopa cimicoides, Fairmaire, *Ann. Soc. Ent. Fr.*, 2, IV, p. 485, 1846.

(Pl. VI, fig. 6, nymph.)

Commonly taken from June to September, and showing considerable variation in the amount of black colour on the pronotum. The eggs were laid in clusters of 30-40, in slits in the epidermis of the stems of various woody plants. The females sat on the eggs, and were much visited by ants. When breeding, they were eminently gregarious, so much so that an infested twig looked as if it were crowded with brown berries, or possibly with galls, though I would not go so far as to suggest cryptic resemblance as an interpretation of the peculiar form. When not breeding, the adults tended to solitary habits, and were frequently taken by sweeping in herbage in the clearings.

***Tragopa guianae*, sp. nov.**

(Pl. III, fig. 2.)

Head pale ochreous, spotted with brown, shining, not punctate, not pubescent, twice as broad as long, margins of genae short, slightly arcuate, lobed at apex; clypeus small, the free margin tri-lobed, hairy at the apex, not projecting beyond margin of genae; eyes grey, prominent, and directed laterally; ocelli yellow, nearer to eyes than to each other, and situated on a level with the centres of eyes. Prothorax dirty white in ground colour, finely and densely punctured with brown, and furnished with short, scattered hairs, shield shaped,

excavated behind shoulders, which are rounded and not prominent; metopodium sloping, very much wider than high; dorsum convex, highest in the middle, non-carinate; posterior process blunt, just covering apex of abdomen and tegmina. A chocolate-brown, irregular, transverse band rising behind the shoulders and extending backwards across the middle of the dorsum; behind this on either side a large sub-triangular brown spot; apex of posterior process brown.

Exposed portions of tegmina bright brown, shining, not punctate. Underparts chocolate-coloured, pubescent; legs yellow; tarsi black.

Long. 3.50 mm.

Lat. (int. hum.) 2.5 mm.

Type: Female.

Two females taken in a colony of *Vanduzea testudinea*, August 2nd, 1922.

The resemblance in colour and pattern between the two forms is so close, that without careful examination, they might be mistaken for varieties of the same species.

***Tragopa occulta*, sp. nov.**

(Pl. III, fig. 1.)

Head black, shining, finely and remotely punctate, half as long as wide; margins of genae arcuate; clypeus small, sub-quadrate, and projecting for about half its length beyond genae; eyes dark brown; ocelli yellow, nearer to eyes than to each other, and situated just above the level of the centres of the eyes.

Prothorax convex, black, shining, finely and thickly punctate, destitute of median line or keel; anterior margin rounded; metopidium sloping, highest above shoulders; humeral angles sub-triangular, only slightly produced; posterior process excavated behind shoulders, apex plicate and sub-acute.

Tegmina with the exposed portion coriaceous, black, and thickly punctate. Underparts and legs rusty black.

Long. 4.50 mm. Lat. 2.75 mm.

Type: Female.

One example taken in deep forest, July 5th, 1922.

This form may prove to be merely a dark variety of some species already known.

***Tragopa scutellaris* Buckt.**

Tragopa scutellaris Buckton, *Monograph of the Membracidae*, p. 156, 1903.

Not uncommon; resembles the last in habits.

***Tragopa tripartita* Fairm.**

Tragopa tripartita, Fairmaire, *Ann. Soc. Ent. Fr.*, 2, IV, p. 490, 1846.

I am indebted to Mr. Funkhouser for determining this most variable form. At first sight the different variations look like distinct species; but the types of colour and patterns imperceptibly grade into one another, and slight differences of size and proportion are not constant and may occur with any colour combination. The variations are not due to sex.

The principal varieties in the Kartabo collection are:

Var. 1. Entirely bronze black.

Var. 2. Head and anterior part of pronotum pale ochreous brown, with a very broad, transverse band, usually black but occasionally chestnut behind the shoulders, and sometimes with the apex of the posterior process black.

Var. 3. Like the last, but with the median band interrupted on the dorsum.

Var. 4. Like the last, but with the transverse band marked with a lateral testaceous spot, and the apex of the posterior process olive-brown.

Var. 5. Pronotum bright reddish brown, obscurely marked behind the shoulders and across the posterior process with darker brown.

This was a common species taken on *Vismia ferruginea* and other plants, frequently in company with *Tragopa cimicoides* and *Horiola arcuata*. The different varieties were found together in the same colonies. They were always visited by ants, which often built shelters of vegetable fibre over and around them.

Horiola arcuata (Fabr.).

Horiola arcuata, Fowler, B.C.A., *Homopt.*, II, p. 86, 909.

A gregarious species which sometimes occurred in considerable numbers, often in association with *Tragopa tripartita* Fairm. It fed on various plants, but especially on the twigs of *Vismia ferruginea*, where it was frequently enclosed in shelters of vegetable fibre which had been built over it by the gnats which always attended it. The eggs were laid in clusters of 30-40 together in slits in the epidermis of the stems.

Horiola ferruginea Fairm.

Horiola ferruginea Fairmaire, *Ann. Soc. Ent. Fr.*, 2, IV, p. 493, 1846.

One male taken in a colony of *H. arcuata*. I believe this to be Fairmaire's species, although the "tres petite ligne blanchatre" at either side of the extremity of the posterior process is replaced in my specimen by a minute white spot.

***Boethoos cinctata*, sp. nov.**

(Pl. IV, fig. 5.)

Head chestnut brown, polished, not punctate, with scattered hairs, surface somewhat irregular, sub-triangular, about as long as wide, projecting forwards; margins of genae oblique, somewhat plicate and extroverted; clypeus small, not extending below genae, tip blunt and thickly hairy; eyes brown, prominent; ocelli yellow, equidistant from each other and from eyes, and situated just below the level of the centres of the eyes.

Pronotum bright chestnut brown, with metallic lustre, punctate, thickly hairy, with a broad transverse gamboge-yellow band over the dorsum behind the shoulders, convex, with the median carina faintly marked; metopodium sloping, wider than high; humeral angles sub-triangular, not much produced; posterior process excavated, and somewhat compressed behind shoulders; lateral margin sinuate; apex rounded.

Tegmina hyaline, with thick dark veins and two infuscated patches at the apex.

Underparts and legs light brown, shining, and rather pubescent.

Long. 7.0 mm.

Lat. 3.5 mm.

Type: Female.

One example collected in a clearing, August 15th, 1922.

A second female in Mr. Beebe's collection, dated July 15th, 1922, is evidently of the same species, but the transverse band is faint sordid yellow.

Boethoos distinguenda Fowler.

Parmula distinguenda Fowler, *B.C.A., Homopt.*, II, p. 91, 1909.

Parmula = *Boethoos*, Kirkaldy, *Ent.*, 37, p. 279, 1904.

Somewhat scarce. Single individuals were found breeding in August and September near colonies of *Tragopa cimicoides*, and other social forms, with whom they shared the attentions of ants.

***Boethoos globosa*, sp. nov.**

(Pl. III, fig. 10.)

Head ferruginous brown, shining, faintly punctate, wider than long, projecting forwards; margins of genae arcuate, produced and extroverted, bordered with yellow; clypeus small, rounded, not projecting beyond genae; eyes grey and prominent; ocelli grey, twice as far from one another as from eyes, and situated on a level with the centres of the eyes.

Pronotum ferruginous brown, polished, finely punctate, slightly pale behind, highest above shoulders; metopidium convex, sloping, twice as wide as high; humeral angles sub-triangular, bordered with yellow; posterior process tectiform, slightly carinate, sub-acuminate, depressed transversely behind shoulders; a bright yellow spot at the middle of the lateral margin on either side.

Tegmina yellowish brown, semi-transparent, the proximal discoidal cell infusate; veins broad, dark, punctured at the base.

Abdomen short and globose; underparts and legs ferruginous; tibiae decorated with yellow; tarsi black.

Long. 3.50 mm.

Lat. 1.75 mm.

Type: Female.

A small reddish brown shining globose species, taken August 5th, 1922, among a colony of *Horiola arcuata* which had been partly covered with vegetable fibre by ants.

Boethoos reticulata, (Fabr.).

Parmula reticulata, Stal, *K. Sven. Vet-Akad., Handl.*, 8, 1, p. 29, 1869.

Parmula = *Boethoos*, Kirkaldy, *Ent.*, p. 279, 1904.

(Pl. VI, fig. 7, nymph.)

Small colonies were found on June 28th, 1922, and on August 4th, 1922, in each case completely enclosed by ants under a shelter of vegetable dust. Early in September, broods appeared on a flowering leguminaceous tree in a clearing which seemed to be attractive to Membracidae, for other forms, such as *M. fusca* and *M. c-album* and *E. monoceros*, etc. were taken upon it. Here, although ants swarmed over the tree and visited the different Membracid colonies, *B. reticulata* lived free, and uncovered. There is considerable variation in the depth of the

ground colour of the pronotum, and in the extent and continuity of the markings, but my collections show that this is not dependent on whether or no the species is covered up by ants.

Vanduzea testudinea, sp. nov.

(Pl. III, fig. 5.)

Head greenish yellow, marked with brown, polished, shining, sparingly pubescent and punctate; base somewhat sinuate; genae rounded, with margins extroverted; clypeus very small, rounded, not projecting beyond genae, hairy at the apex; eyes yellowish grey; ocelli yellow, nearer to margins of eyes than to each other, and situated on a level with the centres of the eyes.

Prothorax sordid white, pubescent, densely punctured with brown, convex, highest above shoulders; humeral angles blunt, not prominent; median carina very slight; metopidium sloping, wider than high; posterior process blunt, tectiform, excavated behind the shoulders, not quite reaching tips of the tegmina. A narrow band along the anterior margin, borders of humeral angles, and apex of the posterior process brown. A broad, irregular, dark brown band extending over the metopidium on either side, often confluent in the middle of the dorsum behind the shoulders, and then turning at an obtuse angle to the lateral margin; a second transverse brown band extending across the dorsum half-way to the apex of the posterior process.

Tegmina hyaline; with a dark, clouded spot in the middle, and another at the apex; veins black and boldly marked.

Underparts bright brown; legs brown, spotted with yellow.

Long. 4.0 mm.

Lat. 2.0 mm.

Type: Female.

Sexes alike.

A small series taken August 19th, 1922, on *Vismia ferruginea*, where they were attended by ants, which had built a slight shelter of vegetable fibre round them.

Amastris elevata Funkh.

Amastris elevata Funkhouser, *Journ. N. Y. Ent. Soc.*, XXX, no. 1, p. 27, 1922.

(Pl. VI, fig. 5.)

This form, which Mr. Funkhouser has kindly determined for me by comparison with his type, is evidently near to *A. obtegens* Fabr. It is a bright green shining species, taken in July and August on a coarse, green herb in a clearing close to the Station. The eggs are laid in clusters of 30-40 in the epidermis of the stem. The nymphs are green; and as they feed flattened close to the petioles and mid-ribs of the leaves, they are almost invisible to a casual glance. Their presence, however, is often betrayed by the swarms of ants which attend them.

Amastris funkhouseri, sp. nov.

(Pl. III, fig. 9.)

Head pale green, roughly sculptured, punctate, coarsely pubescent, about as long as wide; margins of genae sinuate; clypeus small, hairy, not extending

much beyond genae; eyes pink; ocelli bright red, equidistant from each other and from eyes, and situated on a level with the centres of the eyes.

Pronotum greenish yellow, obscurely marked with orange, roughly sculptured, punctate, hirsute; metopidium wider than high, perpendicular, convex, with a faint yellow keel; humeral angles blunt, little produced; dorsum rising abruptly behind the shoulders in a high carinate ridge which slopes backwards and downwards to the apex of the posterior process, which is sub-acute, tectiform, laterally compressed, somewhat excavated behind shoulders, and just reaches the apex of the tegmina.

Tegmina yellowish hyaline, punctate along the costa and at the base; veins pale brown.

Abdomen orange; underparts and legs yellow; tarsi black.

Long. 4.2 mm. Lat. 2.0 mm.

Type: Female.

One female taken by sweeping in a clearing, September 4th, 1922. I have much pleasure in naming this species after Mr. W. D. Funkhouser of the University of Kentucky, in recognition of his assistance in the determination of this and other specimens.

***Amastris vismiae*, sp. nov.**

(Pl. IV, fig. 4.)

Head yellowish brown, shining, faintly punctate, rather roughly sculptured, sub-triangular, broader than long, margins of genae nearly straight and slightly raised; clypeus small, sub-quadrate, hairy at the apex, and not projecting beyond margins of genae; eyes crimson, large, prominent; ocelli yellow, equidistant from each other and from eyes; and situated on a level with centres of eyes.

Pronotum bright reddish brown, punctate, with scattered hairs, arcuate, highest above shoulders, laterally compressed, furnished with a strong median carina which is edged with black; metopidium perpendicular; humeral angles rounded, not prominent; posterior process acute, just reaching apex of tegmina.

Tegmina yellowish hyaline; veins brown; clavus and half of the corium covered by the pronotum.

Long. 5.0 mm. Lat. 2.0 mm.

Type: Female. Male with the abdomen pinkish orange; otherwise sexes alike.

A small series taken in the latter part of July and in August on the brown flowering twigs of the *Vismia ferruginea*, where they were attended by ants. This species readily takes wing when disturbed, but soon returns to the food-plant.

***Aphetea affinis*, sp. nov.**

(Pl. III, fig. 4, 4a.)

Head wider than long, coarsely punctate, base slightly sinuate; margins of genae arcuate; clypeus small, blunt, and not projecting beyond genae; eyes brown; ocelli pink, very small and inconspicuous, twice as far from one another as from eyes, and situated on a level with the centres of the eyes.

Pronotum coarsely punctate; metopidium rounded, sloping, twice as wide as high; dorsum slightly sinuate in the middle, somewhat excavated behind the shoulders; humeral angles blunt, not prominent; median carina percurrent, not very marked; posterior process tectiform or boat-shaped, with the apex acute and just reaching the tips of the tegmina.

Tegmina with the costal area very coriaceous, heavily punctate and coloured like the pronotum; remainder of the corium and the clavus, hyaline, with a small black spot at the apex; three parallel basal veins; discoidal cells absent. The first, second, fourth and fifth apical cells are arranged radially round the apex of the third basal area, and the third apical cell is strongly stylate.

Long. 3.0 mm.

Lat. 1.5 mm.

Type: Female.

A small inconspicuous species which varies considerably in colour. Eight of the nine females in the series have the head and the pronotum pale grass-green in life, but the colour fades in cabinet specimens. The males and the remaining female are greenish brown, with a few obscure brown blotches on the lateral margins and the apex of the posterior process.

This form was taken early in July on the shoots of a vine in an open place in the forest. The eggs were laid in clusters of twenty to thirty together, in slits in the epidermis of the stems. The females remained seated on the eggs, and they and the nymphs, which ran actively over the plant, were much visited by ants.

Cyphonia clavata (Fabr.).

Cyphonia clavata, Fairmaire, *Ann. Soc. Ent. Fr.*, 2, IV, p. 503, 1846.

This species was found from June to September in small numbers on certain favourite shrubs. Both sexes were taken, but I was not able to find the earlier stages, and attempts to induce the adults to oviposit on "sleeved" twigs met with no success. *C. clavata* readily takes wing, but soon returns to the plant. A score or more may be found on the same branch, feeding on the under-sides of the leaves, but they are not gregarious in the sense in which that term has been elsewhere in this paper. Ants abounded on the same foliage, but were never observed to feed from the Membracids. Nevertheless the resemblance between the two forms was very striking in the field, and the mimicry only failed because the Homoptera were sedentary unless disturbed, and did not run restlessly about as the ants did.

* *Cyphonia nasalis* Stal.

Cyphonia nasalis Stal, *K. Sven., Vet-Akad. Handl.*, 3, 6, p. 34, 1858.

A female collected at the Station, November 5th, 1920, answers to Stal's description of this species. It has the facies of *C. clavata*, but is larger and has longer and coarser black hairs. The abdomen and legs are pale with black apices; the paired spines at the base of the posterior process are blunt; and below each, on the side of the thorax, is a shining swollen white spot.

Ceresa vitulus (Fabr.).

Ceresa vitulus, Amyot et Serville, *Hist. Nat. Ins. Hemip.*, p. 540, 1843.

Ceresa vitulus, var. *minor*, Fowler, *B.C.A., Homop.*, II, p. 103, 1909.

Both the type form and the variety were equally common on the coarse herbage in the clearing at the back of the Station.

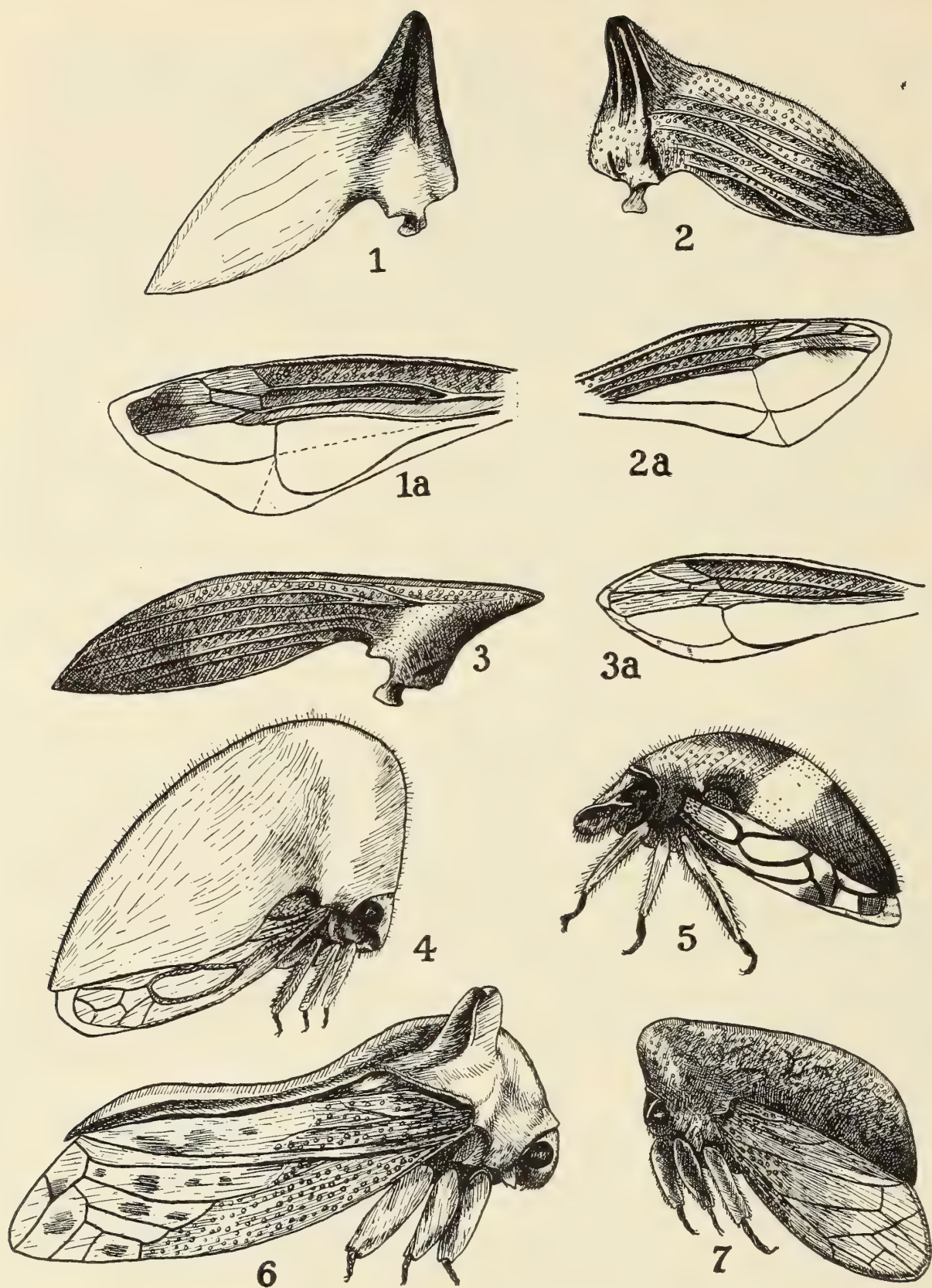


Plate IV.—1, *Hille herbicola*, prothorax; 1a, *H. herbicola*, tegmen; 2, *Gelastigonia hirsuta*, prothorax; 2a, *G. hirsuta*, tegmen; 3, *Polyglyptodes flavicostatus*, prothorax; 3a, *P. flavicostatus*, tegmen; 4, *Amastris vismiae*; 5, *Boethoos cinctata*; 6, *Centruchoides felinus*; 7 *Stegaspis galeata*, Walk., male.

***Polyglytodes flavocostatus*, sp. nov.**

(Pl. IV, fig. 3, 3a.)

Head testaceous brown, punctate, not shining, wider than long, base sinuate; margins of genae nearly straight; clypeus very small, articular margin angular, apex rounded, bristly, scarcely extending beyond margins of genae; eyes brown; ocelli small, yellow, equidistant from each other and from the eyes, and situated on a level with the centres of the eyes.

Prothorax yellowish brown, strongly punctate, furnished with a short, straight horn projecting obliquely forwards and continuous behind with the line of the dorsum, which is non-sinuate and straight from the tip of the frontal horn to the middle of the posterior process, whence it is gradually curved to the apex; basal part of the metopidium carinated, nearly perpendicular and forming an obtuse angle with the frontal horn; humeral angles insignificant; median carina yellow, edged with black, very strong, percurrent; posterior process acute, tectiform, just reaching tip of tegmina, furnished with five yellow costae on either side, extending from the shoulders to the apex.

Tegmina with one discoidal area, the third apical area small; clavus very large; basal and costal regions semi-coriaceous, and punctate, with raised yellow veins.

Underparts and legs brown; tarsi black.

Long. 6.50 mm. (sine cornu. 5.50 mm.). Lat. 2.0 mm.

Type: Female.

A single example was taken August 18th, 1922, on the *Vismia* tree.

Species ?

The determination of the two following species has presented some difficulties. According to the keys of Stal, they should be referred to *Oxygonia* Fairm.² and *Hille* Stal, respectively, on the strength of the presence or absence of a discoidal cell in the tegmen. But Fowler remarks that this character is not always reliable, and moreover *Hille*, according to Stal, is furnished with longitudinal ridges on the pronotum, which are obscure in my series. A closely allied species in the Hope Museum at Oxford is labelled *Hemitycha* (= *Oxygonia* Fairm.) *erythropus* Burm. Mr. Funkhouser has kindly examined my specimens, and refers them to *Polyglytodes* Fowler, but they are different in facies to the types in the British Museum, and the humeral angles, though not very prominent, are more conspicuous. On the whole it has seemed best to follow Stal's arrangement, though when the long-needed revision of this part of the Smiliinae is undertaken, it may be necessary to remove these forms elsewhere, or perhaps include them both in the same genus.

***Hille herbicola*, sp. nov.**

(Pl. IV, figs. 1, 1a.)

Head pale green, punctate, shining, wider than long, with a dark median line; base slightly sinuate; margins of genae sinuate; clypeus rounded and hairy at the apex, and not projecting for as much as half its length beyond genae; eyes red; ocelli yellow, equidistant from each other and from eyes, and situated on a level with the centres of eyes.

² *Oxygonia* = *Gelastigonia* Kinkaldy, *Ent.* 37, 1904.

Pronotum grass-green, coarsely punctate, not pubescent, with a few, slight, irregular, yellowish costae along the lateral margin; metopidium perpendicular, rising into a short, straight, laterally-compressed horn, which is rather variable in height, non-carinate at the sides, and marked broadly with dark brown; median carina sharp, percurrent, edged with black; humeral angles obtusely triangular, not very prominent; dorsum sinuate at base of horn, and gradually sloping to the apex of the posterior process, which is tectiform, acute, and just reaches the tips of the tegmina.

Tegmina with the exposed portion green, coriaceous, and heavily punctate at the base, and infusate and sub-hyaline at the apex; space divided by the claval suture very large and hyaline; three basal veins; basal areas long and narrow; one discoidal cell; apical areas elongate, the third strongly stylate and very small.

Underparts and legs greenish yellow; femora black.

Long. 6.00 mm. Lat.: 2.50 mm.

Type: Female. Sexes alike.

Social: taken in June on low herbage in a clearing near the Station, and attended by ants. The nymphs are green, elongate, and very effectually concealed in their natural surroundings, as they feed flattened against the stems of the host plant. A specimen labelled *T. notata* Walk. in the British Museum, is evidently very close to this species.

***Gelastigonia hirsuta*, sp. nov.**

(Pl. IV, fig. 2, 2a; Pl. VI, fig. 4.)

Head green, with a black, median line, sub-triangular, rather wider than long; base slightly sinuate; margins of genae nearly straight; clypeus hairy, sub-acute, and not projecting for quite half its length beyond genae; eyes red; ocelli yellow, equidistant from each other and from eyes, and situated on a level with the centres of eyes.

Pronotum grass-green, coarsely punctate, hirsute; metopidium carinate, perpendicular, about as wide as high, continued above into a short, straight, laterally-compressed horn, which is provided with three carinae on either side, and with an irregular, black stripe which is continued downwards over the shoulders; humeral angles sub-triangular, not very prominent; dorsum strongly carinate, scarcely at all sinuate at base of horn; posterior process tectiform, acute, just reaching apex of tegmina, and furnished on each side with five or six longitudinal costae.

Tegmina with the exposed portion green, punctate, and coriaceous, infusate towards the apex and along the third basal area; venation as in the last species, but destitute of a discoidal cell.

Underparts and legs greenish yellow.

Long. 6.00 mm. Lat. 2.75 mm.

Type: Male.

Two examples taken June 16th, 1922, in a colony of *Hille herbicola*, which species they closely resemble.

***Telemona spiniger**, sp. nov.

(Pl. III, fig. 3.)

Head wider than long, roughly sculptured, polished, shining; margins of genae sinuate; reflexed; clypeus very small, laterally bi-lobed and rounded at the apex, not projecting beyond margins of genae; base of head somewhat sinuate; eyes pale grey, prominent; ocelli translucent, equidistant from each other and from eyes, and situated on a level with the centres of the eyes.

Pronotum rough, coarsely punctured, shining, not pubescent, much compressed behind shoulders; metopidium twice as high as wide, inclined backwards, slightly sinuate when seen from the side, carinate; humeral angles triangular, strongly produced; dorsum furnished with a high blunt prominence above the shoulders; median carina percurrent and strongly compressed; posterior process very acuminate, lateral margins arcuate when seen from the side, just reaching apex of tegmina.

Tegmina entirely free, yellow, hyaline, punctured at the base, and with a small black spot at the apex of the clavus; veins brown.

Femora somewhat swollen; tibiae spined.

Long. 11.0 mm.

Lat. (int. hum.): 6.0 mm.

Alt: 6.0 mm.

Type: Female.

Described from a female collected at the Station, June 24th, 1922. The colours are evidently faded. The head and pronotum are yellow (? green in life) thickly mottled and punctured, especially along the dorsum, with ferruginous (? red) and the underparts and legs are yellow (? green). This form differs from other species of the genus with which I am acquainted in the shape of the metopidium and posterior process.

Bocydium globulare (Fabr.).

Bocydium globulare, Fairmaire, *Ann. Soc. Ent. Fr.*, 2, IV, p. 508, 1846.

This remarkable Membracid was taken by sweeping in June and again more abundantly in September. The nymphs were not found; and all the examples of both sexes that were obtained were feeding singly on the undersides of green leaves where they were comparatively conspicuous objects. They took wing readily when disturbed, and apparently were never attended by ants, although the latter were common on the foliage around them.

Centruchoides felinus, sp. nov.

(Pl. IV, fig. 6.)

Head ferruginous, with thick yellow pubescence, wider than long, base arcuate and emarginate; margins of genae prominent, sinuate, deeply notched at the apex; clypeus small, depressed, trilobed, with the lateral lobes small and angular and the median lobe larger and rounded, not projecting much beyond genae; eyes brown, prominent; ocelli grey, equidistant from each other and from eyes.

Pronotum ferruginous, punctate, thickly pubescent, furnished above the shoulders with two, stout, pointed horns; metopidium perpendicular, carinate; horns strongly tri-carinate, flattened above, their breadth at base almost equal

to their length; a well-marked percurrent carina arises between the horns and extends to the apex of the posterior process.

Posterior process very acuminate, slightly longer than the abdomen and triangular in section; seen from above, it is narrow at base, slightly expanded behind the scutellum and tapers gradually to the apex; seen from the side, it is sinuate, sloping abruptly to the scutellum, and is then slightly raised again and depressed towards the apex.

Scutellum dark brown, with white tomentose patches, about as wide as long, truncate behind, with a pale denticle lying on either side of the posterior process.

Tegmina ferruginous, semi-opaque, not quite half as long again as abdomen, with numerous, brown, scale-like patches; veins brown, base and costal margin heavily punctate; one discoidal and five apical areas. Wings hyaline grey, with four apical cells. Abdomen rufous brown; ovipositor long and stout; underparts and femora sooty brown to black, with white tomentose patches; tibiae ferruginous, flattened and dilate; tarsi sooty.

Long. 8.0 mm.

Lat. (int. corn.): 3.0 mm.

Type: Female.

Sexes alike, except that the abdomen of the male is short and crimson in colour.

Four females and a male taken in August on the branches of a small tree with reddish bark, common in the clearings. The venation of this form differs somewhat from that of Fowler's type species (*C. laticornis*).

Lycoderes hippocampus (Fabr.).

Lycoderes hippocampus, Stal. K. Sven, Vet-Akad. Handl., 8, p. 52, 1869.

A solitary and rather scarce species, taken occasionally in August and September. The early stages were not found. The insect fed in the axils of the leaves of low shrubs in shady places. The pale green body, seen through the transparent part of the tegmina, and enclosed by the dark apical areas behind and by the pronotum above, gives the whole insect a remarkable resemblance to a partly withered leaf stipule. This form, according to my observations, is not visited by ants.

Stegaspis laevipennis (Fairm.).

Stegaspis laevipennis, Walker, List Homopt. Ins. Brit. Mus., p. 635, 1850.

Two females taken September 9th, 1922, on a red-barked shrub in a clearing. The insects fed in the axils of the leaves, and bore an unmistakable resemblance to stipules.

Stegaspis galeata Walker.

Enchenopa galeata Walker, List Homopt. Ins. Brit. Mus., p. 486, 1850.

Stegaspis galeata Walker, Ibid, Supp., p. 341, 1858.

Hypsoprora insignis Buckton, Mon. Mem., 1909.

Stegaspis insignis, Funkhouser, Journ. N. Y. Ent. Soc., XXX, no. 1, p. 34, 1922.

(Pl. IV, fig. 7; Pl. V, fig. 5.)

A gregarious form, attractive to ants, and not uncommon on green vines and juicy shoots in shady places from June to September. The colour of my

series varies from ochreous brown to rusty black, and the sexes are dimorphic, for the male lacks the frontal horn.

The above synonymy is suggested after examination of Walker's specimens in the British Museum, which are identical with the examples from Kartabo. Mr. Funkhouser has suggested to me that *S. folium* Oliv. may be a synonym. Stal (K. Sven. Vet-Akad Handl., 8, p. 54, 1869) supposes *S. folium* to be identical with *S. melanopetala* Oliv. Stal's description is of the male sex, and Stoll's figure 80, and possibly 48 also, probably represents this unhorned form. Stoll's figure 31, according to Stal, is of *S. fronditia* Fabr., and this is evidently near to, if not identical with, the female of the species under discussion. Until the types of the older writers can be re-examined, Walker's name has priority over that of Buckton.

Ischnocentrus niger Stal.

Ischnocentrus niger Stal, *Ofv. K. Vet-Akad. Forh.*, p. 293, 1869.

A male and female taken at the beginning of August, feeding singly on the bark of twigs in a shady place. Their appearance was very ant-like, and some of the ants, which were numerous on the foliage, were gathered round them.

Fowler (B.C.A., *Homop.*, II, p. 155) regards Stal's species, *I. niger* and *I. ferruginosus*, as the sexes of the same form. This conclusion is borne out by my two examples, of which the male is black and the female is rich brown. The only structural difference between them is that the posterior process of the male is slightly reflexed, while that of the female is straight.

Tolania scutata Stal.

Tolania scutata Stal, *K. Vet-Akad. Handl.*, 3, 6, p. 37, 1858.

A female, taken September 5th, 1922, on the bark of a shrub at the edge of a clearing. Stal's type was a male, but I have little doubt from his description that this belongs to the same species.

Tropidaspis carinata (Fabr.)

Tropidaspis carinatus, Stal, *K. Sven. Vet-Akad. Handl.*, 8, p. 56, 1869.

(Pl. V, fig. 4.)

This form was fairly common in shady places on the bark of twigs, and was invariably attended by ants. It was, moreover, the only species over which the ants showed any solicitude when disturbed. Twice I found a small colony with their eggs completely enclosed with some Coccids under an earth-crust. When the latter was broken into, some of the nymphs were seized by the ants and carried for a short distance, but they were soon abandoned. At other times, *T. carinata* fed in the open; and although the ants visited the colonies, they did not display unusual perturbation when the Membracids were interfered with. In the males of my series, the tegmina are more opaque and the general colour is darker than in the females. The pale fascia across the scutellum is sometimes almost absent in both sexes.

***Tropidaspis minor*, sp. nov.**

(Plate V, fig. 3.)

Head deflexed, longer than wide, punctate; ocelli situated close to upper margins of eyes.

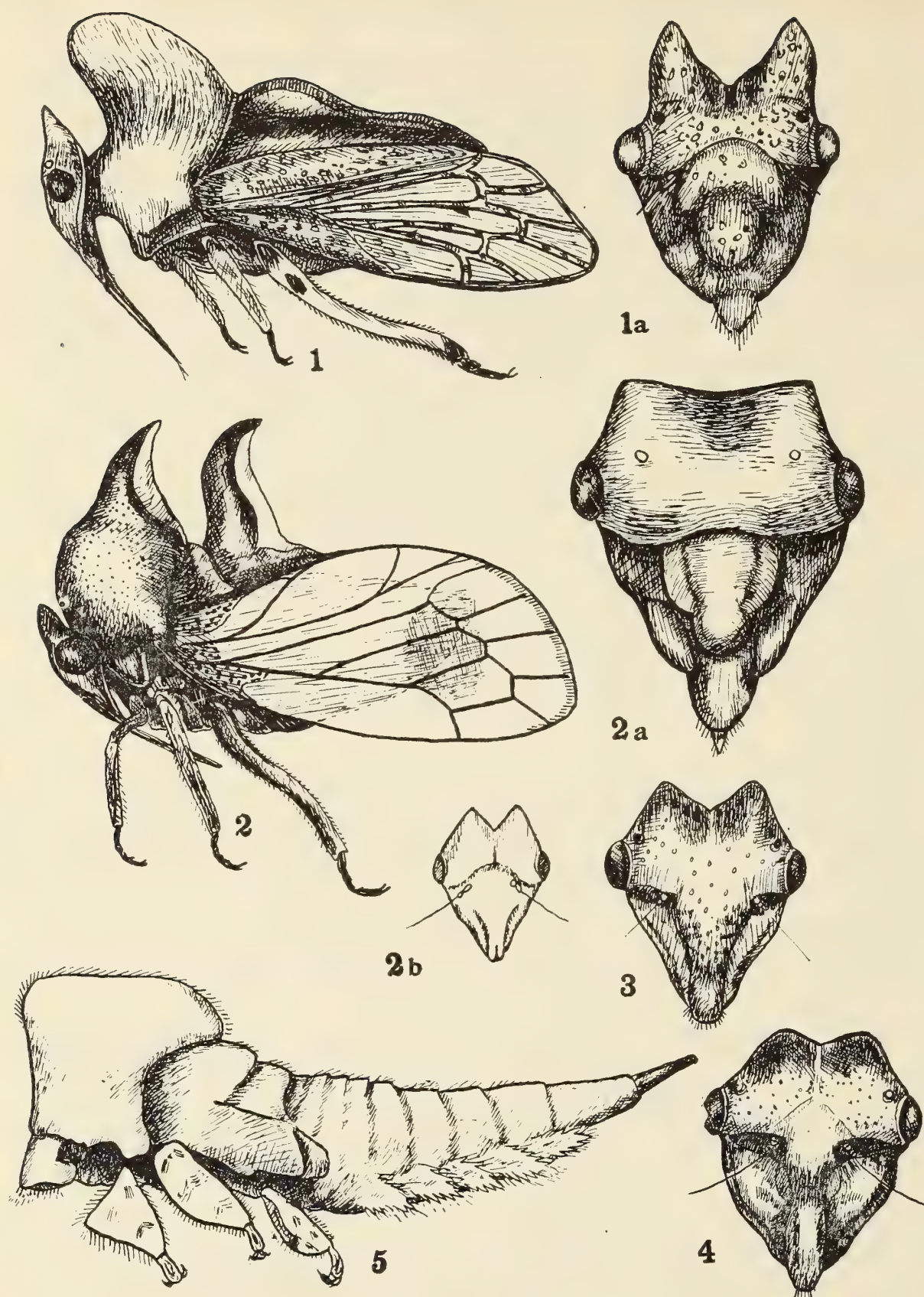


Plate V.—1, *Tropidaspis cornuta*; 1a, *T. cornuta*, frontal view of head; 2, *Lophyraspis armata*; 2a, *L. armata*, frontal view of head; 2b, *L. armata*, head of nymph of the third instar; 3, *Tropidaspis minor*, frontal view of head; 4, *T. carinata*, Fabr., 5, *Stegaspis galeata*, Walk., nymph of the fifth instar.

Pronotum with the humeral angles blunt and little produced; somewhat excavated behind the shoulders; posterior margin gently sinuate, and furnished with a slight median carina. Scutellum as long as the abdomen, acuminate, and with a sharp percurrent carina extending to the apex.

Head, prothorax and scutellum pale testaceous, densely punctured and variegated with black and chestnut brown.

Tegmina hyaline, coriaceous, and punctate at the base; veins raised and broad, spotted with brown and white.

Legs and tarsi sordid ochre; the hind tibiae curved and furnished with three rows of spines.

Long. 3.50 mm.

Lat. 1.50 mm.

Type: Female.

Resembles the last species, but is smaller and paler in colour, and the base of the head is more acutely lobed.

Two females were taken at the end of July on their flat oval egg-cases on the bark of a shrub in the jungle, attended by ants.

***Tropidaspis cornuta*, sp. nov.**

(Plate V, figs. 1, 1a.)

Greenish yellow, heavily mottled and punctate with black and brown. Head sub-triangular, much longer than wide, base produced into two conical lobes above the eyes; margins of genae somewhat arcuate; clypeus very small and scarcely projecting beyond genae; eyes brown; ocelli yellow, situated at the base of the lobes, close to, but above, the inner margins of eyes.

Pronotum hexagonal, with the anterior margin rounded and raised, posterior margin straight, and somewhat impressed in front of shoulders; furnished with a strong keel, which is produced above the shoulders to form a high, laterally-compressed, rounded crest, projecting forwards.

Scutellum not quite as long as the abdomen, very narrow, acuminate, with a sharp percurrent keel, which, seen from the side, is somewhat sinuate, and laterally-compressed behind the middle.

Tegmina semi-opaque, coriaceous, punctate at base and along the costal and claval margins; veins broad, raised, and decorated with lighter spots. Under parts pitchy brown; tibiae and tarsi yellow, spotted with black; hind tibiae curved and furnished with three rows of small, black spines.

Long. 3.50 mm.

Lat. 1.50 mm.

Type: Female.

Male slightly smaller and paler.

The absence of discoidal cells, the position of the ocelli and the unarmed scutellum justify the inclusion of this form in *Tropidaspis*. The lobes of the base of the head are much more pronounced than in the type species, but *T. minor* is transitional in this respect.

T. cornuta is a small brown rough-looking insect. Two examples were taken in August on the petiole of a shrub in dank jungle. The female was sitting on a flat condante egg-case, attended by ants.

***Lophyraspis fowleri*, nov. nom.**

Gerridius scutellatus Fowler, *B.C.A., Homop.*, II, p. 166, 1909. (*nec*
Lophyraspis scutellatus Stal.)

After a careful comparison of the characters determining the genera

Lophyraspis Stal and *Gerridius* Fowler, I have come to the conclusion that the distinctions between them are not well defined, and that therefore Fowler's genus, erected in 1909, cannot stand. Mr. Funkhouser writes to me that he is also of this opinion. The name *scutellus* being preoccupied in *Lophyraspis*, it is necessary to re-name Fowler's type species, and I suggest that it be known henceforward by the specific designation *fowleri*.

L. fowleri was found in July, in a shady clearing, on the shoots of a shrubby plant infested with *L. armata*. It was gregarious and was attended by ants. The Membracid itself has a peculiarly ant-like appearance when feeding, owing to its habit of raising its long, curved, hind tibiae and gently waving them to and fro in the same manner as its congener *L. armata* and many Aphididae.

The determination of the two following species has presented some difficulties, as I have not seen Stal's types.

The structure of the head closely resembles that of *Ischnocentrus* and *Tropidaspis*. Stal separated *Lophyraspis* and *Lamproptera* on the form of the base of the head, and the number of discoidal cells. Fairmaire remarks of *Lamproptera*, "elytres tout a fait semblables a celles des Lycoderes pour les cellules," and figures *L. vacca* with one discoidal cell as in *Lycoderas*. The only example of the genus to which I have had access is the single specimen of *Lamproptera stylata* Buckt., in the Hope Museum, and there the venation is identical with that of *Lophyraspis*; *Tropidaspis*, according to Stal, had no discoidal cell, and yet the venation is unmistakably of the same type. The discrepancy is due to the use of the term discoidal. In *Lophyraspis* the external, and only true, discoidal cell, is formed by the forking of the radial vein. The internal cell is really the radial-medial basal area, for the radial and medial veins are conjoint for some distance from the base of the tegmen. The same thing occurs in *Lamproptera stylata*. In *Tropidaspis*, all three main veins are distinct at the base, and the radial areolet is so elongated that its discoidal nature is masked. Fowler remarks that in his types of *Tropidaspis affinis*, there are two discoidals on one side and one on the other; this is probably due to the shifting of the bifurcation of the radial vein.

***Lophyraspis armata*, sp. nov.**

(Plate I, fig. 10; Plate V, figs. 2, 2a, 2b.)

Head bronze-black, punctate, triangular, rather longer than wide, base raised into a high, slightly sinuate crest, which is obtusely angulate laterally, and bi-cornulate only in the nymph; lower margins of the vertex produced above a deep sulcus in which the antennae are inserted; margins of genae sinuate; clypeus trilobed, not projecting beyond genae; ocelli equidistant between eyes and median line, and situated on a level with the upper margins of eyes, vertex between them strongly impressed.

Pronotum bronze-black, punctate, strongly convex; humeral angles obtuse and slightly prominent; median carina slight in front and rising behind into a high, backwardly projecting pointed crest, with the anter or edge ferruginous, blunt, and the posterior sharp and knife-like, with a black fascia bordered behind with white; posterior margin arcuate.

Scutellum ferruginous, shining, acuminate, scarcely longer than wide, marked laterally with white tomentose patches; median carina developed into a crest as high as that of the pronotum, rounded in front, recurved behind and bordered with black and white fascia; apex white. Tegmina hyaline, shining, polished, coriaceous and punctured at base, with a median cloudy brown spot; veins and margin brown. Underparts and femora sordid yellow; tibiae and tarsi black; hind tibiae long, curved, hairy, furnished with numerous small spines; hind tarsi very long.

Long. (front of head to apex of tegmen): 4.00 mm. Lat. 1.20 mm.

Type: Female.

Male similar, but with dorsal crests less developed.

These Membracids were taken several times between June and August on twigs in shady places. They are social, and remain upon, or near, their egg-cases, where they are much visited by ants. They and the dull green nymphs are active and move about freely. When feeding, the adults have a curious habit of waving their long hind tibiae in the air as Aphides are accustomed to do. This gives them a remarkably ant-like appearance in the field; and when ants are present in numbers it is difficult to distinguish one from the other.

Stal (K. Sven. Vet-Akad. Handl., 1869, p. 56) in a footnote describes *L. cristata*, in which the pronotum and scutellum are both furnished with high crests. The description is inadequate for accurate determination, but it is quite possible that *L. cristata* is identical with the form described here.

Lophyraspis pygmaea (Fabr.).

Lophyraspis pygmaea, Stal, K. Sven. Vet-Akad. Handl., 8, 1, p. 55, 1869.

This form resembles the last but is smaller. The pronotum is bronze-black and punctate, convex and rounded behind, with a very slight median keel. The base of the head and scutellum are bright brown, and the underparts and legs are sordid yellow.

The scutellum is triangular, rather longer than wide, transversely convex, with a black median keel more developed behind, where it dips abruptly to the apex which is white and very acute.

Tegmina as in the last; but with the apical margin more broadly infusate. The hind tibiae are long and curved, and furnished with short close spines.

Endoiastus productus Osborn.

Endoiastus productus Osborn, Zoologica, Vol. III, no. 10, p. 233, 1921.

(Plate I, fig. 8, eggs.)

The genus *Endoiastus* was erected by Fowler for the reception of *E. caviceps*; *E. productus*, which differs from the type species in its dark colour, more slender form and narrower head, was described by Osborn from material collected by Dr. Wheeler from *Tachigalia* at Kartabo in 1920.

In 1922, I found this Membracid only in one spot, where, however, it bred in numbers from June to September. The eggs were laid in slits in the epidermis of the stems, petioles, and on the undersides of the leaves of the *Tachigalia*. About thirty were deposited together, usually in a double, but sometimes in a single, row, and the adults and nymphs clustered together in crowds under the foliage. The nymphs were active, dark green and not mealy, but the adults were sluggish and seldom moved unless touched.

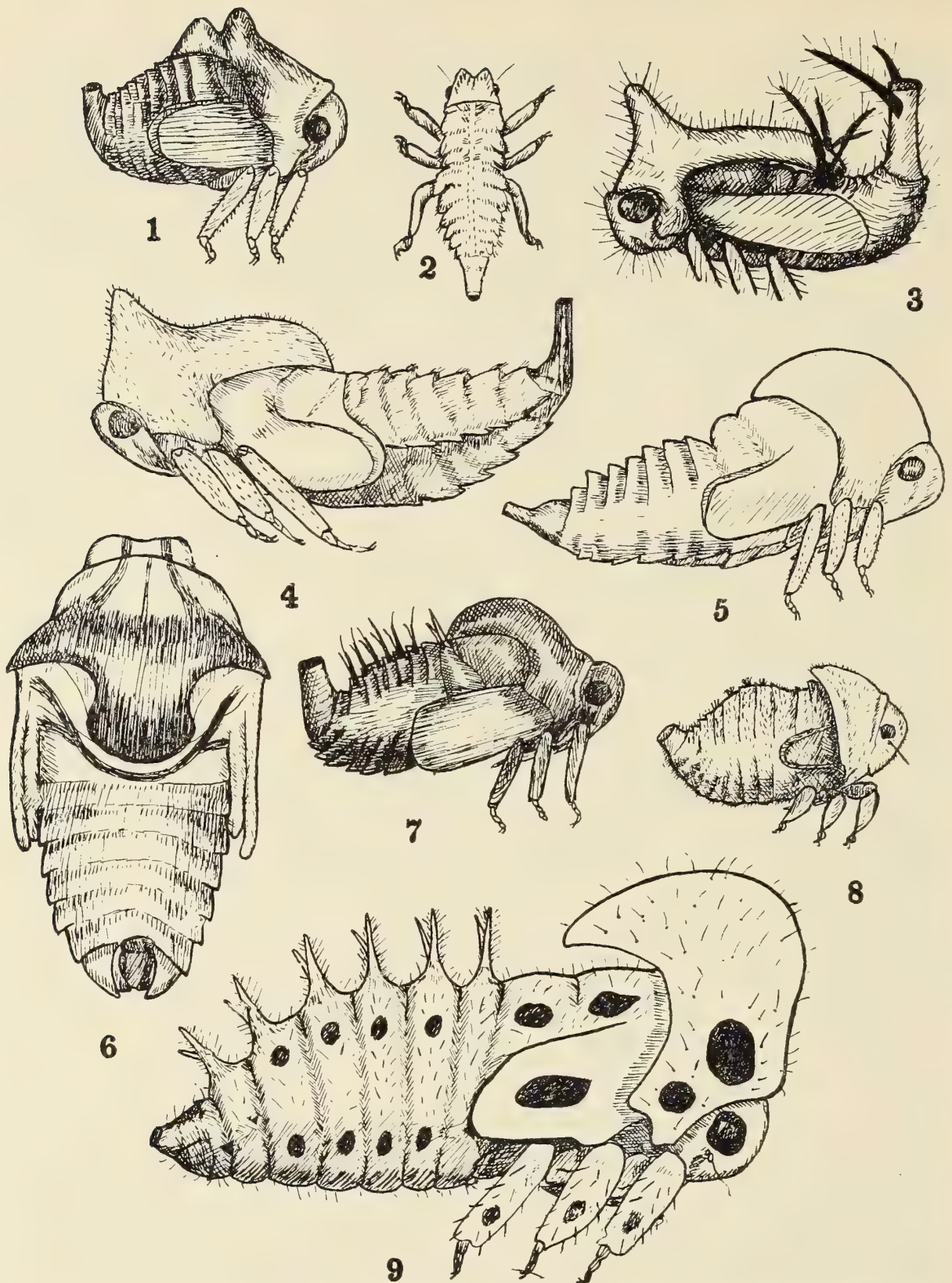


Plate VI.—Nymphs of, 1, *Bolbonota aspidistae*, fifth instar; 2, *Enchenopa bifenestrata*, Funkh., second instar; 3, *Campylenchia nutans*, Germ., fifth instar; 4, *Gelastigonia hirsuta*, fifth instar; 5, *Amastris elevata*, fifth instar; 6, *Tragopa cimicoides*, Fabr., fifth instar; 7, *Boethoos reticulata*, Fabr., fifth instar; 8, *Tropidocyta bulbosa*, fifth instar; 9, *Membracis c-album*, Fairm., fifth instar.

Dr. Wheeler (*op. cit.*, no. 4) has given an account of the relations of the host plant to the ant which live in the hollow petioles of the leaves and feed on the excreta of the Membracids.

Aethalion reticulatum (Linn.), var. *albo-nervosum*.

Aethalion reticulatum, Germar, *Mag. der Ent.*, IV, p. 95, 1835.

Aethalion reticulatum, var. *albonervosum* Fowler, *B.C.A.*, p. 171, 1909.

(Plate I, fig. 11, eggs.)

Taken in some numbers in August on the branches of a tree within fifty yards of the Station landing-stage. This species is gregarious and the females, which are sluggish and reluctant to take wing, can be picked off the eggs with the fingers. The egg-cases, though large, are of the usual Membracid type, with the eggs embedded in pale brown elliptical masses of wax. The colony was much visited by ants.

This form possesses scarcely a single distinctive Membracid character. But the head of the nymph, apparently less modified than that of the adult, shows affinities with certain Centrotinae; and therefore it has seemed best here to follow Fowler's arrangement, and include this anomalous genus in the Membracidae.

GEOGRAPHICAL DISTRIBUTION.

The Membracid fauna of the Kartabo forest is intermediate between that of the Panama region and the Amazon basin. Thus of forty species whose distribution is given by previous writers, twelve are peculiar to Guiana and Brazil, and ten to Guiana and the Central American area. As sixteen are common to all three regions, it is evident that many neotropical Membracidae have an extensive range; and as further data are obtained, we shall probably find that numerous forms have a wider distribution than appears at present. This is already clear if we take the genera rather than the species, for almost every genus of the Kartabo collection is widely distributed between Lat. 20° N. and Lat. 25° S.

At the same time, the extensive range of many forms is rather remarkable, for, as I have pointed out elsewhere, the primaeval forest which occupies so much of the South American Continent is not the most favoured environment for most Membracidae. Thus of sixty-nine species at Kartabo, forty-two were taken in and around clearings, and only thirteen inhabited the deeper forest. Fourteen were intermediate in their haunts, but even this group was confined to the lighter trails and glades where the shade was not too dense. Of course even the clearing dwellers are shaded by vegetation. The only form which seems able to bear the full glare of the sun is *Enchenopa lanceolata*, which inhabits low plants on the open river

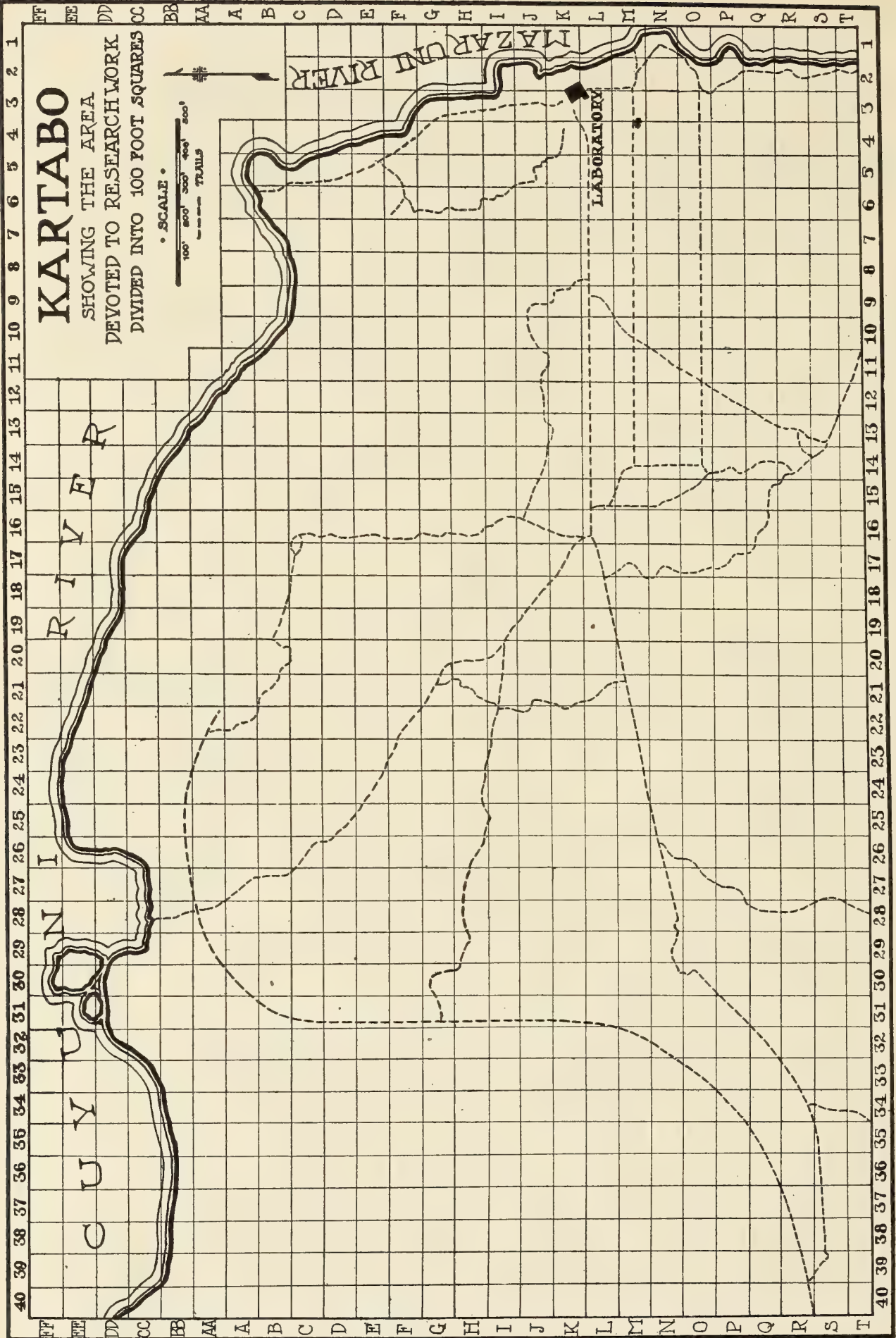


Plate B. Area devoted to research at Kartabo.
Drawing by John Tee-Van.

bank, and is exposed from sunrise to sunset. But the darker, damper parts of the forest are poor in Membracidae, and as the greater part of equatorial South America is clothed with this deep forest, the wide dispersal of the light-loving forms is curious. Unless they can sustain themselves among the tree-tops, a point on which at present we have no information, they must have followed the lines of more open forest, and clearings in virgin jungle are relatively scarce and restricted in extent. We are perhaps too apt to regard the tropical forest zone as a homogeneous area, and overlook that within its bounds conditions vary greatly, so that, to many species, migration is only possible along certain definite tracks or routes.

LIFE-HISTORIES AND HABITS.

The Membracidae of Kartabo are divided rather sharply into two natural groups, the forest forms and the clearing forms. The first group is much the smaller, and except for *Darnis partita* and *D. latior*, includes chiefly such insonspicuous species as *Tropidocyta gibbosa*, *Tropidaspis carinata*, *Endoiastus productus* and the *Bolbonotas*. Even of these, many haunted places where the shade was not too dense; and the dark swampy forest along the river banks was almost destitute of Membracidae. On the other hand, the secondary growth round the Station, and in the abandoned cassava clearings further afield, was rich both in individuals and in species. This was partly owing to the change in flora induced by felling of the forest, and partly because Membracidae are light-loving insects. This is not to imply that they seek the full sunshine,—the only species that seemed able to tolerate the open ground was *Enchenopa lanceolata*,—but most other forms sought bright diffused light under foliage round the clearings.

Professor Poulton (*Buckton, Mon. Mem.*, p. 9) quotes Mr. Nelson Annandale's observations in Malacca, where "insect-eating animals retire to rest during the hottest hours of the day, and at this very time, insects, including such cryptic forms as the stick-like Phasmids, move about freely, assume forms, and occupy environments in which they are quite conspicuous." Funkhouser (*Mem. Cornell Univ. Agric. Exp. Stat.*, p. 392, 1917) observed that the Membracidae of the Cayuga Lake Basin were most active during the hottest parts of the day. Possibly the Kartabo Membracidae were on the whole more active in the morning, and the usual time for the emergence of

the adults was in the forenoon; but this is only a general impression, and the eggs seemed to hatch at all hours. I have captured *Tragopa cimicoides* and *Ceresa vitulus* on the exposed tops of herbage in clearings between three and four o'clock in the afternoon; but most of the insects appeared to take cover under the leaves when the sun was high. Nearly all the species recorded are rather sedentary, and occupy positions where they are permanently shielded from the direct rays of the sun.

The marked division of the Kartabo Membracid fauna into forest and clearing forms opens the question whether many of the latter have extended their range of late years, in correlation with the extension of settlements and cultivated ground. From examination of collections in the Georgetown and New York Museums, it appears that the species from Kartabo, when represented, are generally distributed along the coast and up the rivers as far inland at any rate as Kaieteur, and probably have a foot-hold everywhere where the forest is scanty enough to afford the optimum of light and shade. Many places up the rivers have been cleared and settled for the last two hundred years, and the immigration of light-loving forms is not necessarily recent.

Without special botanical knowledge, it has not been possible to give a list of hosts, but my notes indicate that many forms are monophagous, or at least restricted to a few species of plants. Probably this is the reason why many species are gregarious and form colonies, not only with their own kind, but with other genera. Some of these are recorded below:

Tragopa cimicoides

Enchenopa bifenestrata

Tragopa partita

Tragopa cimicoides

Horiola arcuata

Boethoos distinguenda

Membracis c-album

Membracis fusca

Boethoos reticulata

Enchenopa monoceros

Horiola arcuata

Boethoos globosa

Horiola ferruginea

Vismia ferruginea

Vanduzea testudinea

Tragopa guianae

Tragopa tripartita

Vismia ferruginea

In passing, one might perhaps comment on the superficial resemblance of some of these gregarious forms. Such, for instance, are *Tragopa guianae* and *Vanduzea testudinea*, *Horiola arcuata* and *H. ferruginea* and *Boethoos globosa*.

The Membracidae often occur in such numbers on an individual host that it is rather remarkable that the plants attacked are seldom distorted or galled. The only species at Kartabo which regularly gives rise to a specific deformity is *Tropidocyta gibbosa*. Here the inflorescence of a certain shrub is attacked when in bud. The stem becomes nodose and woody, and the buds abort and fall off. The reason for the apparent immunity of most hosts is that the Membracids infest only the stem, and do not touch the shoots or leaves until the latter are fully formed.

The egg-masses of Membracidae are usually distinctive objects, and those of which I have records can be referred to two principal types. In one the eggs are deposited in a mass of waxy colleterial fluid, which soon hardens on exposure to the air, and the epidermis of the plant is little, if at all, lacerated. In the other, there is very little fluid, and the eggs are deposited in incisions in the plant's tissues. With certain exceptions, the first is the general type of the Membracinae and Centrotinae; the second is that of the other sub-families. The form and colour of egg-cases of the first type have already been dealt with in the list of species at the commencement of this paper, and vary considerably in different genera.

Some older writers have credited the Membracidae with parental care for their eggs, on the ground that some forms remain seated on the mass for some time after oviposition is complete. The idea probably arose because the process is often a somewhat lengthy one, and the mother sits quietly sucking for hours or even days while the mass beneath her grows larger. But I am not quite sure that the idea is as far-fetched as some other writers have supposed. There is no need to credit the female Membracid with conscious instincts of maternity; but the fact that she remains on her nursery may serve to protect it, either by keeping away certain enemies, or, conceivably, by regulating the temperature or moisture.

Early in July I had colony of *Bolbonota aspidistrae* under daily observation, and the following are extracts from my diary:

- July 4th: Six nests and some late nymphs beside the Puruni Trail. Females in five of the nests.
- July 5th: Two more nests with females on the same plant. Took three females away from nests.
- July 7th: Three out of four remaining females still on eggs. One unoccupied nest hatching.
- July 8th: More nymphs hatching from one occupied and one empty nest. Ants round all nests. Two deserted nests look crumbling.
- July 10th: Nymphs still emerging. Two empty nests rather shrivelled and discoloured; a third half broken away.
- July 12th: All females gone and the two latest nests beginning to hatch out. The nest originally unoccupied and two whose females were removed do not seem to have produced nymphs, for the eggs are shrivelled.

Observation on three more marked nests of the same species later on showed that nymphs would appear when the female was removed; but out of fifteen or so eggs in each mass, only half a dozen nymphs emerged, and examination showed that the remaining eggs were flaccid, shrivelled and apparently broken.

On the other hand, some experiments with *Enchenopa bifenestrata* gave negative results, and the proportion of hatching eggs seemed unaffected by the removal of the female.

The duration of embryonic life is not easy to determine since the eggs are not all laid at once and therefore hatch at irregular intervals. Observations on certain species gave the following approximate results:

<i>Enchenopa bifenestrata</i>	8 days
<i>Enchenopa lanceolata</i>	6 days
<i>Tragopa partita</i>	?5 days
<i>Bolbonota aspidistrae</i>	6 days
<i>Campylenchia nutans</i>	7 days

The nymphal period was longer than I expected to find it in the tropics where all life seems keyed to such a high and exuberant pitch. The following list is compiled from certain species whose nests were isolated and kept under daily observation:

Instars	1st	2nd	3rd	4th	5th
<i>Bolbonota aspidistrae</i>	2 days	5 days	4 days	6 days	7 days
<i>Lophyraspis armata</i>	——	——	?4 days	6 days	8 days
<i>Aconophora compressa</i>	3 days	5 days	?4 days	6 days	9 days
<i>Enchenopa bifenestrata</i>	——	3 days	3 days	5 days	9 days

I have also kept colonies of fifth instar nymphs of *M. tectigera* and *Enchenopa nutans* under observation for eight days and ten days respectively.

The nymphs of most of the species described in this paper are often quite active, and seek to escape by dodging round the stem of the plant, but in no case were they ever seen to hop. The adults are frequently disinclined to move, but when they make up their minds to leave the plant, they spring away like lightning. It is easy to see a Membracid arrive. It is still more easy to see a valuable specimen depart; but in the intermediate stages of its transit it is usually invisible. Many forms have a remarkable homing faculty; and within half an hour of their departure, they may be found feeding again on the very branch from which they previously fled headlong.

ATTENDANCE BY ANTS.

It has long been known that certain species of Membracidae are visited by ants for the sake of their excretion, the so-called "honeydew." Belt (*Naturalist in Nicaragua*, p. 227, 1874), Rice (*Insect Life*, p. 243, 1893), Baer (*Bull. Soc. Ent. Fr.*, p. 306, 1903), Branch (*Kansas Univ. Sci. Bull.*, VIII, 1913), Lamborne (*Trans. Ent. Soc.*, January, 1914), Funkhouser (*Mem. Cornell Univ. Agric. Station*, II, 1917), and others, have published observations on this point.

In all the known cases, the association seems to be a sort of loose commensalism, and not the close interdependence that is found between ants and some other insects. Rice states that the nymphs of *Entylia sinuata* reached the adult state in two weeks if ants were present and in one if they were absent; but the statement is rather general, and possibly experiments with different controls might have given other results. Branch considered that ecdysis was irregular in the absence of ants; but as the experiments were conducted in the laboratory, it is more probable that malnutrition was responsible. Funkhouser, who investigated this problem, found

that the presence or absence of ants had no effect on development. I endeavoured to work out this point, but the attempts were not wholly successful, owing to the difficulty of isolating the colonies of Membracids on their natural food-plant under conditions where ants were numerous and heavy rain-storms frequent. As far as they go, my results confirm those of Funkhouser.

Most of the records suggest that the ants feed only from the anal tube. This is not altogether correct, for although the visitors have learned that stimulation of the Membracid secures the extrusion of a drop of excreta, yet they readily take what had already fallen. This gives the key to the origin of the association. Ants of various species swarm over the foliage in the forest whether Membracids are present or not. They visit the nectaries on the leaves of plants, bird-droppings, excreta of other insects, such as Coccids, etc. Hence a colony of Membracidae is a god-send and a crowd quickly gathers round it. In fact, so numerous and so ubiquitous are foraging ants, that where a few examples only of a species of Membracid are taken, it is not always easy to say whether it is regularly visited or not, and it is no wonder that most gregarious Membracidae are thus attended.

The list of unattended forms given elsewhere in this paper shows that they all are solitary when adult.³ In fact habit rather than physiology seems to determine whether ants shall or shall not visit them. Thus *Stegaspis laevipennis* and *Lycoderes hippocampus* were not attended; *Stegaspis galeata*, which occurs in colonies, was visited freely. However, Funkhouser (*op. cit.*, p. 399) brings evidence to suggest that social habits are not the only factor concerned. The host plant often plays a considerable part. *Endoiastus productus* feeds on *Tachigalia* shoots, and the hollow petioles are occupied by ants (Wheeler, *Zoologica*, 1921), which naturally resort to the manna that the Membracids strew at their doors.

According to my observations at Kartabo, when an ant-attended colony is disturbed, the ants attack the invader savagely, but pay no attention to the Membracids. The only exception to this was in a colony of *Tropidaspis carinata*, which had been completely covered up with vegetable fibre. When the roof was broken in, half a dozen ants each seized a nymph, but after carrying them aimlessly for a short distance, they dropped them without further interest. *T. carinata*, *Horiola arcuata*, and *Boethoos reticulata* were the

³ The early stages are not known.

only forms that I found completely enclosed in ants' nests on twigs. Here at least I expected to find evidence of more interdependence; but after some study I came to the conclusion that the association was fortuitous, for all three species flourished equally well when unenclosed. The covered twig was always infested with Coccids, and probably these, rather than the Membracids, were objects of care. The Membracids seem indifferent whether the ants cover them up or not. When the shelters are broken, the adults jump away and the exposed nymphs, as I have frequently observed, continue to feed, sometimes for days afterwards, on the exposed bark, although movement a few centimetres to right or left would bring them under cover again.

I must express my thanks to Dr. W. M. Wheeler, who has been good enough to determine the following species of ants for me:

Camponotus femoratus Fabr.; taken in attendance on *Tragopa cimicoides*, *Endoiastus productis*, *Lophyraspis armata*, *Horiola arcuata*.

Crematogaster (*Orthocrema*) *limata* Smith; var. taken in attendance on *Horiola arcuata*.

Azteca paraensis Ferel; taken in attendance on *Campylenchia nutans*.

Pheidole sp.; taken in attendance on *Amastris elevata*.

Pheidole fallax Mayr.; taken in attendance on *Boethoos testudinea*.

ENEMIES.

Our present knowledge of the enemies of Membracidae is very inadequate, and I regret that I am able to add little or nothing to it.

Aconophoroides gladiator and *Cymbomorpha vaginata* were occasionally found to be captured by hunting spiders, and *Membracis tectigera* was taken from a web. Internal parasites in the nymphs were not observed. Possibly the constant visits of ants tend to prevent this kind of attack. Nevertheless a Myrmarid, of species as yet undetermined, was seen to parasitize the eggs of *Tragopa cimicoides*, *Aphetae affinis*, and *Campylenchia nutans*. The Myrmarid, which was slow and furtive in its movements, like many of its family, crawled leisurely over the eggs, ovipositing in each, in some cases while the Membracid female was still sitting on the mass, and before laying was finished. Ants were running around,

and even over the Membracid, but the parasite completely disregarded them and crept under the mother's wings to accomplish its task.

FIELD OBSERVATIONS ON FORM AND COLOUR.

Buckton's *Monograph of the Membracidae* includes an interesting and suggestive essay by Professor Poulton, on the "Meaning of the Shapes and Colours of the Membracidae." In the writer's own words, his remarks are merely suggestions, and are in no sense dogmatic utterances. "I feel," he says, "that in this most remarkable group of insects, the examination of figures, or even of the specimens themselves in a museum, can only occasionally afford us the foundation for a valuable opinion as to the bionomic meaning of the forms and patterns. But such an examination continually suggests possible interpretations which may lead the observer of the living species to think, and may sometimes even direct him into the right track."

It has been of interest to compare my notes taken in the field with the interpretations that study of similar forms in the cabinet suggested to such an authority as Professor Poulton; and possibly a discussion of observations made independently from the two points of view may not be out of place here. It may well prove that my own conclusions will not hold good for the same species found under different conditions elsewhere; but field observations on tropical Membracidae are somewhat scanty, and if only for this reason, the following notes may be worth recording.

Following Professor Poulton, let us take first the genus *Membracis*. All the forms collected at Kartabo are comparatively large and conspicuous insects, black, usually variegated with white, and in one instance (*M. fasciata*) with orange. Professor Poulton suggests that the foliaceous pronotum may resemble one of the semi-circular pieces of leaf that the leaf-cutting ants carry in procession to their nests. This theory, though ingenious, is hardly acceptable to anyone who has seen the supposed mimics and models in their natural haunts, although it is true that the ants will carry off, not only blackened leaves, but also bits of stick and petals of flowers. The general type of colouring that prevails throughout the genus is bold and striking, and by no means harmonizes with the surroundings. This kind of colouring is usually supposed to be associated with

"unpalatableness,"⁴ and I advance another explanation, which is, however, quite hypothetical. These Membracids are gregarious, and adults and young frequently feed together on the same twigs. The young forms are covered with a white flocculent powder, which renders them so conspicuous that we can only suppose that enemies which hunt by sight recognize them as unpalatable and pass them by. The colour pattern of, say, *M. tectigera* is bold enough by itself, but when seen upon a plant infested with nymphs of its own kind, it possibly has some cryptic value, falling into line, not with its vegetable surroundings, but with its own conspicuous and unpalatable brood. I put forward this theory with reserve, for it could hardly apply to the orange and black species with whose bionomics I am not acquainted; but it would cover the case of *Enchenopa lanceolata*, also a black and white form, with a curved frontal horn, which bears not the least resemblance to a cut leaf. This species has likewise mealy white young, and forms conspicuous colonies on low-growing plants.

On the other hand, *Atta* mimics may well exist, and the instance observed by Slater (Poulton, *Proc. Zool. Soc.*, p. 4, June, 1891) may be a case in point. Infestation by *Amastris elevata* has a superficial resemblance to an *Atta* raid in progress. The green crescentic forms of the Membracidae are certainly very like pieces of cut leaf, and as the colonies are usually attended by ants, the *mise en scene* is complete. But it seems unnecessary to interpret this as mimicry of harvesting ants. The colour and form of the Membracids are equally well adapted to resemble leaf stipules, or the foliaceous expansions of the stem which are sometimes found in green plants, and this I believe to be the real explanation. Other forms in my collection to which this applies are *Cymbomorpha vaginata*, *Telamona spinigena*, *Hille herbicola* and *Gelastigonia hirsuta*. It may be remarked that all those species were taken only on green plants. *Amastris vismia*, a brown species close to *A. elevata* in all but colour, was taken only on the reddish twigs of *Vismia ferruginea*.

The suggestion that the general form and colour of genera such as *Enchenopa* and *Tropidocyta* are cryptic is supported by my field observations. *T. neglecta* and *Campylenchia nutans* fed in the axils

⁴ Mottram (*Proc. Zool. Soc.*, p. 253, 1917), has sought to determine experimentally the factors which cause animal colour patterns to appear conspicuous in nature. According to his conclusions such a form as *M. c-album* must be considered eminently conspicuous, for it is black with white superimposed upon it, and one at least of the component colours is nearly circular in outline.

of leaves, and simulated buds or stipules. The long-horned forms such as *E. albidorsa* and *E. monocercus* resembled broken petioles or thorns, though it should be remarked that in every case the host plant itself was thornless. *Aconophora compressa*, which is superficially similar in shape to the last two species, likewise resembled a bit of stick; and the nymphs, which have short red horns, fed in rows along the stems and were very thorn-like.

The question of the colour background is of interest. Most of the Membracids collected fed, not on the green leaves, but on the brown or reddish stems of the plants, and I never found a bright green Membracid on a brown stem. A certain slender straggling tree, common in open places, had the twigs and undersides of the leaves covered with rusty brown powder. This tree was the chosen host of many Membracidae, themselves all brown. Such were *Enchenopa monoceros*, *Campylenchia nutans*, *Aconophoroides gladiator*, *Centruchoides felinus*, and the solitary form *Stegaspis laevipennis*, which was almost indistinguishable from a leaf stipule. On the other hand *Stictocephala indeterminata*, *Aphetea affinis*, *Amastris elevata*, etc. appeared only on green stems or twigs. Nevertheless complete colour harmony with surroundings is not nearly so important (speaking from the point of view of a human being) as some students of animal coloration would have us believe. One is gradually forced to the conclusion that an insect with variegated pattern can pass muster very well anywhere in the chequered light and shade of the forest, among the bewildering profusion of vegetable shapes and forms. For instance, the remarkable genera *Pterygia* and *Hypsoprora* are roughly sculptured and coloured black and white, a form and pattern which, if seen in a museum, would immediately suggest imitation of a natural background of lichenized bark. Unfortunately I obtained only one example of each genus, but in each case the insects were taken on green foliage. The *Pterygia* was actually feeding at the base of a leaf some distance from the ground, and until I took it in the net, I mistook it for a resting beetle or microlepidopteron, deceived by the long antenna-like supra-humeral processes. The *Hypsoprora* resembled a bit of fallen bark or a bird dropping; but in this case I am not sure that the insect had not been disturbed by my passage, and alighted momentarily on the leaves.

Sphongophorus is represented in the collection by *S. guerini*. This grotesque insect was found singly on the shoots of shrubs and

herbaceous plants in clearings, and bears an undoubted resemblance to a broken or withered leaf stem.

Species of the genus *Umbonia* have been compared to red-striped thorns. *U. spinosa* has been taken at Kartabo, but I did not find it myself, and made no field observations. There seemed to be no common plant with thorns of this type. *Aconophoroides gladiator*, which has a brown striated body and a sharp red-tipped horn, was found on brown thornless twigs. In both cases colour alone probably affords adequate concealment, and the shape of the pronotum is relatively unimportant.

The genera *Boethoos*, *Vanduzee*, and *Stictocephala* were generally represented at Kartabo by small forms whose colour and pattern, while inconspicuous, did not appear to have any special cryptic or mimetic design. The same applies to various species of *Tragopinae*. Some of these *Membracids* form colonies and are attended by ants under shelters of vegetable debris; others feed openly on leaves and stems. It must not be overlooked that forms which are individually inconspicuous may be quite obvious when present in numbers. A single example of *Tragopa cimicoides*, for example, is easily missed; but a branch where the egg-laying females cluster like berries is a comparatively striking object.

Ceresa vitulus and its variety *minor* were abundant in the sun-bleached herbage of clearings. Their greenish colour serves to conceal them, and the sharp supra-humeral spines suggest that they would be unpalatable to some enemies.

The habits of *Bolbonota* are interesting. Professor Poulton thus comments on the genus: "They closely resemble seeds, also small lumps of earth. They would be well-concealed upon rough bark." According to my observations, *Bolbonotae* of all species sat in plain view on the broad leaves of *Aspidistra* and other plants in open trails and clearings. In spite of their small size, they were visible several feet away; but they were not readily recognized because they closely resembled the little shrivelled scales and bits of bark which fell in profusion from the foliage overhead. They were very active, taking wing at the least alarm, and when they were present in numbers, the pit-pat when they alighted on the leaves was plainly audible. *Tropidocyta bulbosa* was frequently taken in the same places. In fact, from the point of view of habits, this species is very closely related to *Bolbonota*.

Darnis partita and *D. latior* are solitary when adult, and are both conspicuously coloured black and yellow forms. They feed in the axils of leaves in the shade of the forest. Certain other Homoptera, for instance, some of the Cercopidae and Jassidae, which haunted the deeper forest, likewise tended to conspicuous patterns of black, red and yellow.

Stegaspis and *Lycoderes* are both cryptically coloured genera. *Lycoderes hippocampus*, which fed in the axils of leaves of low-growing plants, was a fine example of resemblance to a bract or stipule. *S. galeata* is beautifully fashioned like a bit of dead leaf. The sexes are dimorphic, since the male has no pronotal horn and the nymph is a remarkable form with foliaceous legs and an elongated abdomen with ctenate lateral lobes. It feeds closely pressed against rough twigs with which its colour harmonizes admirably and the comb-like processes which clasp the stem on either side further tend to obscure its outline. *Bocydium globulare* was not uncommon, but I am unable to suggest an explanation of its extraordinary form. It was a solitary and comparatively active species, usually found a few feet from the ground. At first sight I occasionally mistook it for a Culicid or other small Dipteron, though to suggest mimicry here is hardly justified. That remarkable insect, *Heteronotus armatus* and its allies must be regarded as mimics of Hymenoptera. This species frequented the upper surfaces of leaves in open sunny places. They took wing with a loud buzzing noise and were capable of considerable, though slow, flights. Their appearance when flying is much like that of a large Chalcid or yellow Aculeate, and it is quite possible that we have here an example of Mullerian rather than of Batesian mimicry, for the spines of the pronotum are capable of inflicting a sharp stab when the insect is handled. The resemblance to a Hymenopteron is less striking when the Membracid is at rest, as it lacks the quick jerky movements of a wasp. Perhaps in compensation for this *Heteronotus* is wary and readily takes wing. This applies also to the curious species *Cyphonia clavata*, which was not exactly gregarious, although several individuals were generally to be found on the same bush. The resemblance to an ant is as striking in the field as in the cabinet, but, having achieved the appearance of the model, the mimic fails to reproduce its behaviour. It feeds chiefly on the undersides of the leaves in open places, and as it is sedentary, unlike the restless ants, which it should be remarked are common on the foliage round it, its immobility tends to betray it.

But like *Heteronotus*, it is wary, and a rustle, such as would be produced by a bird alighting on the bush, is sufficient to send every *Cyphonia* into the air.

I agree with Professor Poulton (*Proc. Ent. Soc. London*, p. 19, 1913) that the fact that a mimic does not reproduce the actions of its supposed model, is no argument for assuming that the resemblance between them is due to chance; and where an insect is structurally incapable of mimicking behaviour, it is interesting to find greater wariness or wing power by way of compensation, so that if the deception is detected, the mimic can fall back on its second line of defence, and take refuge in flight.

Some of the small Centrotinae show the exact reverse of the *Cyphonia* case. *Ischnocentrus niger*, *Lophyraspis fowleri*, and *Lophyraspis armata* are not in the least ant-like in form and yet they are apparently ant mimics. These forms are social and cluster thickly along twigs and stems where they are freely visited by ants. The hind legs are long, black, and curved and during feeding they are raised into the air and waved to and fro.

The casual observer has the impression of a mass of ants with restless limbs. When the plant is shaken, the ants rush hither and thither to attack, and the Membracids, which are alert and active, rush up and down with them. Without close inspection it is impossible to distinguish between the Homoptera and their attendants. Probably the action was originally nothing more than a rhythmical motion similar to what we see in sucking Aphides, and has secondarily become an effective "mimicking" device.

The association of Membracidae with ants has perhaps played a part in the evolution of their colour and form. The ants attack any creature which touches the plant, and thus undoubtedly afford protection to the colonies of Homoptera that they attend. At the same time, their bustling presence often betrays their hosts. A list, which is given in detail below, was prepared of the Kartabo Membracidae, not including those species of which only one example was obtained, or of which no notes were made. The remaining species were divided into those attended, and those not attended by ants; and each division was as far as possible classified into cryptic, mimetic and neutral forms, the last including all species which were inconspicuously coloured and yet bore no apparent resemblance to natural objects. As far as they go, the results are interesting. Out of thirty-five ant-attended species, sixteen are cryptically coloured,

three are ant-mimics by behaviour, and eleven are neutral. Certain black and white *Membracids* are included, but could not be classified. In eleven species not attended by ants, four are cryptic, four are mimetic, and two have conspicuous colouring of the type usually called "warning." *Bocydium globulare* is included, but could not be classified. The results are proportionately the same if the genus instead of the species is taken as the basis of the table.

The conclusion to be drawn is that ant-attended forms actually have less need for exact cryptic or mimetic resemblance, and thus from the point of view of colour and form tend to fall into panmixia. This division contains a high proportion of neutral forms, and none that are structural mimics of other insects. The unattended species are usually solitary; probably the ant-association was due in the first place to gregarious habits. The list included all the structural mimics, three striking examples of cryptic colouration and no neutral forms. The inference is that unattended species have greater need of protective devices.

The cases of *Bolbonota aspidistræ* and *Tropidocyta bulbosa* are of interest. The adults are well protected by habit and appearance, and are not attended by ants except when egg-laying. Then the female sits motionless, sometimes for days together, on a white egg-case many times her own size, and thus forms part of a comparatively conspicuous object. At these times, and also during nymphal life, both species are freely visited by ants. This supports the view that gregarious habits conduce to the ant-association; and that ant-attendance partly compensates for imperfect cryptic or mimetic resemblance, and may even have helped to account for that condition.

Professor Poulton holds the view that the remarkable forms and colours of many of the Membracidae have been produced through strict natural selection. The sanction for this selection is the assumption that the enemies of the Membracidae have visual powers at least equal to those of man. Birds and reptiles suggest themselves as possible enemies, but evidence on this head is still very scanty. The principal enemies that I observed at Kartabo were spiders, and in this connection it may be remarked that two out of the three species taken were cryptically coloured.

The present state of our knowledge is too imperfect to allow us to dogmatize, but it is difficult to believe that the number and vigi-

lance of enemies that hunt by sight can account for a natural selection strict enough to produce the mimetic forms that we think we see. I say *think we see* advisedly, because among the wealth of animal and vegetable forms in the tropical jungle, it is easy to be over-ridden by a fascinating conception, and seek mimetic interpretation where simpler explanations would suffice. It should be understood that this is not to deny the justice of many such interpretations—*Cephonía clavata* or *Sphongophorus guerini* by themselves would silence such wrong-headed scepticism—but after some time spent in the jungle, I am driven to the conclusion that any object, preferably coloured green or brown, stands a reasonable chance of being overlooked.

The advocates of protective resemblance by natural selection urge that the selection is so strict that the least deviation from the optimum is wiped out. But critics of this theory have frequently pointed out that in the earlier stages there can have been no such close likeness to the model, and yet the mimic survived. Further, the more closely the mimic approached to the model, the less strict would the selection become, because the chance of escaping enemy scrutiny would be greater. I confess that, in spite of *Cyphonia clavata* and *Sphongophorus guerini*, I find this objection unanswerable at present.

Species Attended by Ants.

<i>Enchenopa monoceros</i>	
“ <i>bifenestrata</i>	
<i>Campylenchia nutans</i>	
<i>Bolbonota aspidistae</i>	
“ <i>inaequalis</i>	
<i>Tropidocyta bulbosa</i>	
<i>Aconophoroides gladiator</i>	
<i>Aconophora compressa</i>	cryptic
<i>Amastris elevata</i>	
“ <i>vismiae</i>	
<i>Gelastigonia hirsuta</i>	
<i>Hille herbicola</i>	
<i>Aphetes affinis</i>	
<i>Centruchoides felinus</i>	
<i>Stegaspis galeata</i>	
<i>Aethalion reticulatum</i>	
 <i>Ischnocentrus niger</i>	
<i>Lophyraspis fowleri</i>	mimetic
“ <i>armata</i>	

<i>Tropidocyta gibbosa</i>	
<i>Vanduzea testudinea</i>	
<i>Boethoos distinguenda</i>	
" <i>reticulata</i>	
<i>Tragopa cimidoides</i>	
" <i>scutellaris</i>	neutral
" <i>guianae</i>	
" <i>tripartita</i>	
<i>Horiola arcuata</i>	
<i>Endoiastus productus</i>	
<i>Tropidaspis carinata</i>	
<i>Membracis c-album</i>	
" <i>fusca</i>	
" <i>tectigera</i>	not classified
" <i>arcuata</i>	
<i>Enchenopa lanceolata</i>	

Species Not Attended by Ants.

<i>Lycoderes hippocampus</i>	
<i>Stegaspis laevipennis</i>	
<i>Sphongophorus guerini</i>	cryptic
<i>Ceresa vitulus</i>	
<i>Heteronotus armatus</i>	
" <i>albospinosus</i>	mimetic
" <i>vespiformis</i>	
<i>Cyphonia clavata</i>	
<i>Darnis partita</i>	non-mimetic, ? warning
" <i>latior</i>	
<i>Bocydium globulare</i>	not classified

THE NYMPHAL FORMS.

The nymphs of the neotropical Membracidae are not often seen in collections; for owing to their soft bodies, they do not make satisfactory pinned specimens, and the collector, unless he is especially interested in the group, passes them by in favour of the adults. The development of some North American species, however, has been studied in detail, notably by Funkhouser (*Cornell Univ. Agric. Exp. Sta.*, mem. II, 1917)

The nymphs of most species, as far as is known, are imperfect editions of the adult form, and already the 4th and 5th instars fore-

shadow, as it were, the horn of *Enchenopa*, the rounded hood of *Boethoos* and *Tropidocyta*, the lateral processes of *Tragopa*, etc. The colouring also follows that of the adult in a general way. For instance, the nymphs of *Hille herbicola* and *Amastris elevata* are green, while those of *Enchenopa monoceros* and *Campylenchia nutans* are brown. The fact that the resemblance of form is less exact than that of colour supports the view that in many instances the Membracidae escape notice more by a general harmony with their surroundings than by definite resemblance to particular objects. The soft-bodied nymphs, which seem to need at least as much protection as the hard-bodied adults, often live side by side with the latter in the same environment, and yet lack those details of form and pattern which give their parents such wonderful likeness to surrounding objects; and which, we are sometimes told, are necessary to concealment, owing to the strict natural selection to which the species has been exposed.

We are hampered in any discussion of this subject by our ignorance of the early stages of some of the most wonderful of the "protected" species, such as *Hypsoprora*, *Sphongophorus*, *Heteronotus*, and certain *Lycoderes*. Nevertheless it is perhaps safe to venture on the generalization that as a rule conspicuously coloured adults have conspicuous nymphs and vice versa, although the conspicuousness is not always produced in the same way. For instance, at Kartabo, the black and white forms, *Membracis* and *Enchenopa lanceolata*, have nymphs with a white flocculent covering, frequently spotted with black. In the same way, adults which are cryptic as a rule possess nymphs which are cryptically, or at all events "neutrally" coloured. The only Kartabo species whose nymph is more brightly coloured than the adult is *Aconophora compressa*, in which the young of the 4th and 5th instars have rudimentary sharp red-tipped horns, and are decorated with white patches. It is possible that the frequent association with ants, as suggested elsewhere in this paper, may partly compensate for the absence of special protective devices in the nymphs of some species.

But certain forms do possess adaptive characters peculiar to the nymphal stages. Such are the pectinate lateral processes of *Stegaspis galeata*, which clasp the stem and undoubtedly tend to obliterate the outline of the insect; and the ? *Stegaspis* nymph, figured by Poulton (*Proc. Zool. Soc.*, p. 462, 1891) as an *Atta* mimic is perhaps another example of especial cryptic adaptation during development. Fowler

(*B.C.A.*, p. 4, 1909) remarks that the nymphs of *Membracis* "are very curious, being of the same shape as the perfect insect, but formed of separate upright narrow plates of different heights." This general statement is probably based on the remarkable specimen in the Hope Museum, figured by Buckton (*Mon. Membracidae*, pl. II, 4a) as the nymph of *M. continua*; but this form is not invariable for the genus, since the nymph of a typical species such as *M. c-album* is quite different in appearance, and has a semi-circular hood.

The nymphs of many genera possess dorsal spines which may be defensive in function. The number and arrangement vary a good deal even within the genus. For instance, according to Funkhouser, the nymph of *Campylenchia latipes* is furnished with broad median dorsal plates, whereas the nymph of *C. nutans* possesses long curved paired spines on the 2nd and 3rd abdominal segments, and near the orifice of the anal tube. These anal spines are remarkable and nothing is known of their function.

Enchenopa monoceros has a double row of little bristly lappets along the dorsum; *E. bifenestrata* is covered only with a short pilose coat; *Tragopa cimicoides*, *Amastris elevata* and *Gelastigonia hirsuta* are spineless; *Bolbonota inaequalis* has a double row of minute bristles; *Aconophora compressa* has a pair of strong curved spines on the mesothorax and on abdominal segments 2-4. The white nymphs of *Membracis* and *Enchenopa lanceolata* are thickly spined along the dorsum, but there seems to be no correlation between the conspicuous colouring and the presence of dorsal spines, for the cryptically coloured nymphs of *Boethoos reticulata* are spinous also. There are some remarkable nymphal forms in the Hope Museum. One, figured by Buckton (*op. cit.*, pl. 19, fig. 6) as *Holophora pertusa*, has a pair of stout backwardly-projecting spines on the mesothorax only. If it really belongs to this species and not, as is more probable, to *Umbonia*, it is of interest because the pronotum is developed into a high sharp point above the shoulders, which is lacking in the adult. Another specimen, labelled *Triquetra nigrofasciatus* Buckt. possesses both meso- and meta-thoracic spines. Two very curious forms appear in the *Cyphonia* series in this collection. One has the mesothorax and abdominal segments 2-3 strongly spined, and in addition, the pronotum is produced in front into a high bifid spike. Another has strong paired spines on the metopidium, and on the posterior process, while the mesothorax and abdominal segments 2-7 are likewise armed.

The phylogenetic value of the nymphal form is very doubtful, but if we are prepared to accept such evidence, we must suppose that the Centrotinae with their exposed scutellum are nearest to the ancestral type, although the extraordinary diversity of form in the sub-family forbids us to theorize. But certain Centrotinae possess a second character which is found only in the nymphs of other sub-families, namely the raised margin of the base of the head above the occiput. In *Tropidaspis carinata* this is small and only slightly lobed. In *T. minor*, the elevated part is more strongly bifid, while in *T. cornuta*, it is deeply cloven and bicornulate, almost as in *Lamproptera capreolus*. In *L. stylata* the lobes are produced into horns long enough to bear a superficial resemblance to antennae. In *Endoiastus productus* the head is laterally compressed and produced into two narrow lobes, divided by a groove. In *Lophyraspis pygmaea* the base of the head is little raised and scarcely sinuate, while in *L. armata* it is high, obtusely cuneiform, and almost straight. But the nymphs of both the last named species have the base of the head strongly divided into two conical horns as in *Tropidaspis cornuta*, and this character can be seen in the nymphs of other sub-families at certain stages. In *Amastris elevata*, for example, it is not distinguishable after the second or third instar, but in *Enchenopa bifenestrata* it persists up to the fourth.

The wing venation of some of the Centrotinae, such as *Bocydium*, *Lycoderes* and *Centruchoides*, is in its way as specialized as that of the other sub-families, but the venation of the *Tropidaspis-Lophyraspis* group, although it has suffered the modification by reduction common to all the Membracidae (Funkhouser, *Ann. Ent. Soc. Amer.*, vol. VI, no. 1) is in some respects more generalized. There is apparently no anastomosis between radius, media and cubitus, save that in *Lophyraspis* the two former are united for the basal third of their length. The important inter-radial and medio-cubital cross-veins occupy typical positions, and the only other cross-vein is a radio-medial as in some Membracinae. Mr. Funkhouser, in his valuable paper cited above, figures the wing pad of the nymphs of some species, and it is impossible not to notice that the venation of the adult *Tropidaspis* follows the primitive tracheation of more specialized forms, especially as regards the tracheation of the hind wing, which, although the venation is reduced, is in some respects more generalized than the tegmen.

KEY TO SPECIES INCLUDED IN THIS PAPER.

The following key to the species included in this paper is intended primarily for field workers in British Guiana, and is therefore necessarily somewhat arbitrary. It is based on the keys of Fowler in the *Biologia-Centrali-Americana*, but I have relied as far as possible upon the form and colour of the pronotum, rather than upon the characters of the venation, which are often confusing to those who have not previously studied the group.

- (B) A. Scutellum wanting, or obsolete, or entirely concealed by the pronotum.⁵
- (53) 1. Tarsi of equal length, or with the posterior pair the longest.
- (21) 2. Anterior tibiae dilated and foliaceous (*Membracinae*).
- (6) 3. Pronotum foliaceous, elevated, semi-circular or nearly so when seen from the side (*Membracis*).
- (5) 4. Black, or black and white.
- a. Entirely black.....*Membracis fusca*.
- b. With an oval, and a crescentic, white spot.....*Membracis c-album*.
- c. With two oval white spots.....*Membracis carinata*.
- d. With a horizontal white band.....*Membracis arcuata*.
- e. Anterior border and a spot on the dorsum, white.
Membracis tectigera.
- f. With two quadrate white spots on the dorsum
Membracis humilis.
- (4) 5. Black, variegated with orange.....*Membracis fasciata*.
- (3) 6. Pronotum not rounded, nor foliaceous nor elevated when seen from the side.
- (12) 7. The pronotum produced in front into a longer or shorter horn. (*Enchenopa*).
- (11) 8. Dorsum even when viewed from the side.
- (10) 9. Horn not lobed at the apex.
- a. Colour chestnut: horn long.....*Enchenopa monoceros*.
- b. Colour fawn-brown: horn curved.....*Enchenopa nutans*.
- c. Colour black with a white band on dorsum
Enchenopa albidorsa.
- d. Colour orange or red: horn short.....*Enchenopa pulchella*.
- e. Colour black, with white dorsal spots.. *Enchenopa lanceolata*.
- f. Horn short and stout: black with
dirty-white mark on dorsum.....*Enchenopa bifenestrata*.
- (9) 10. Horn bi-lobed at apex: legs not very foliaceous (*Lycoderes*, *Centrotinae*).
- a. Horn stout: form triangular: colour brown
Lycoderes laevipennis.
- b. Horn black and slender: abdomen green
Lycoderes hippocampus.

⁵ The genera *Lycoderes* and *Stegaspis* properly belong to the sub-family *Centrotinae*, which has the scutellum developed and uncovered; but the foliaceous species included here are so readily confused with some of the *Membracinae*, that it has been thought better to place them in the first part of this key.

- (8) 11. Dorsum tuberculate when seen from the side.
Horn truncate at the apex.
a. Black and white: very asperatè: not laterally compressed
Hypsoprora aspera.
b. Black or brown: foliaceous: much compressed laterally.
(No horn in male).....*Stegaspis galeata* [Centrotinae].
- (7) 12. Pronotum not horned in front.
- (14) 13. Pronotum with fungiform processes on dorsum. Head 3-lobed.
(*Sphongophorus*) with the processes resembling the capital letters EL.....*Sphongophorus guerini*.
- (13) 14. Pronotum without fungiform processes.
- (16) 15. Pronotum with two long lateral processes above the shoulders, and
a sharp tubercle at the posterior apex. Black and white
Pterygia uropygii.
- (15) 16. Pronotum without lateral processes above the shoulders.
- (20) 17. Pronotum obtusely angulate or rounded in front and strongly
carinate. Dorsal ridge even, when viewed from the side. Legs
scarcely foliaceous.
- (19) 18. Tegmina with three discoidal areas (*Tropidocyta*).
a. Covered with white tomentose hairs...*Tropidocyta pruinosa*.
b. Legs and pronotum pale ochreus, with an ill-defined brown
patch on dorsum. On distorted shoots
Tropidocyta gibbosa.
c. Small and globose: dark brown: pronotum rounded in front,
as in the last.....*Tropidocyta bulbosa*.
d. Rather larger than the last two, and with the pronotum
obtusely angulate in front.....*Tropidocyta neglecta*.
- (18) 19. With two discoidal areas, but otherwise resembling the last genus
(*Leiocyta*).
a. Pale, with a large bright chestnut mark on the dorsum
Leiocyta beebei.
b. Brown, with two ill-defined darker spots on the dorsum
Leiocyta spiralis.
- (17) 20. Form very small and globose: pronotum rounded in front and cor-
rugated, rugose or tuberculated on the dorsum. Colour black
or dark brown (*Bolbonota*).
a. Very small: with the tegmina entirely transparent
Bolbonota inaequalis.
b. Larger: tegmina opaque, and often spotted with yellow:
dorsum corrugated.....*Bolbonota pictipennis*.
c. As in (b): dorsum with two carinated tubercles
Bolbonota aspidistrae.
d. As in (c) but with the tubercles less high, and expanded
transversely.....*Bolbonota corrugata*.
- (2) 21. Anterior tibiae not foliaceous.
- (33) 22. Central (3rd) apical areole of the tegmen elongate, and truncate at
its base. (Darninae.)

- (32) 23. Tegmina not more than half as long as wings: pronotum not nodose nor spined.

(27) 24. Pronotum covering at least half of corium: head much broader than long.

(26) 25. Colour black and yellow: surface polished.
 a. With three transverse dorsal yellow bands.. *Darnis partita*.
 b. With the lateral margins only yellow..... *Darnis latior*.

(25) 26. Colour green..... *Stictopelta indeterminata*.

(24) 27. Tegmina almost free.

(29) 28. Pronotum with a long horn: superficially resembling *Enchenopa*
Aconophora compressa.

(28) 29. Pronotum without a horn: colour green.

(31) 30. Pronotum compresso-elevate, semi-circular in side view
Cymbomorpha vaginata.

(30) 31. Pronotum not elevated, but tectiform and convex
Rhexia kartabensis.

(23) 32. Tegmina twice as long as wings: pronotum nodose and spined
 (*Heteronotus*).
 a. With the posterior spines comparatively short and stout
Heteronotus armatus.
 b. With the posterior spines longer and more slender
Heteronotus vespiformis.
 c. With the spines as in the last, but paler, and the form of the
 of the nodes somewhat different.. *Heteronotus albispinosus*.

(22) 33. The central (3rd) apical areole of the tegmen petiolate, that is to say, enclosed by a forked (Y-shaped) vein.

(39) 34. Tegmina very coriaceous externally, with the veins scarcely distinguishable, and the free margins broad (*Tragopinae*).

(38) 35. Tegmina almost entirely concealed by the pronotum (*Tragopa*).

(37) 36. Shoulders produced: colour greenish brown.
 a. Shoulders very prominent..... *Tragopa cimicoides*.
 b. Shoulders less pronounced..... *Tragopa scutellaris*.

(36) 37. Shoulders not produced: colour various.
 a. Entirely black..... *Tragopa occulta*.
 b. Greenish: broadly marked with brown on the dorsum
Tragopa guianensis.
 c. Colour very variable, ranging from black to red; and the pattern also very diversified..... *Tragopa tripartita*.

(35) 38. Tegmina with the external half free (*Horiola*).
 a. Chestnut, with a pale saddle-shaped mark.. *Horiola arcuata*.
 b. Bright brown, with the shoulders outlined with yellow
Horiola ferruginea.

(34) 39. Tegmina membranous or coriaceous only along the external margin: veins distinct (*Smiliinae*).

(43) 40. Tegmina with the clavus uncovered.

(42) 41. Posterior process of the pronotum trifurcate (*Cyphonia*).
 a. Pronotum entirely black..... *Cyphonia clavata*.
 b. With a white spot on either side of the prothorax
Cyphonia nasalis.

- (41) 42. Pronotum not trifurcate, but rounded, and furnished with two humeral spines. Colour greenish.....*Ceresa vitulus*.
- (40) 43. Tegmina with the clavus, and more or less of the corium, covered.
- (47) 44. Pronotum horned in front.
- (46) 45. Horn erect: colour green.
 a. Surface glabrous, not hairy nor costate..*Hille herbicola*.
 b. Surface hirsute and costate.....*Gelastigonia hirsuta*.
- (45) 46. Horn projecting obliquely forwards: colour brown, with yellow costae.....*Polyglyptodes flavicostatus*.
- (44) 47. Pronotum not horned.
- (49, 50) 48. Pronotum compresso-elevate, semicircular in side view.
 a. Green*Amastris elevata*.
 b. Brown*Amastris vismiaie*.
- (50) 49. Pronotum compresso-elevate, not semicircular in side view.
 a. With an obtusely angulate process above the dorsum
Telemona spinigera.
 b. Flattened in front and raised and carinate behind
Amastris funkhouserii.
- (48, 49) 50. Pronotum not compresso-elevate, but convex, tectiform, though scarcely keeled.
- (52) 51. Ground colour black or brown, variegated with white or yellow.
 a. Large, hairy, with a transverse yellow dorsal band
Boethoos cinctata.
 b. Smaller than the last, and with a lateral yellow spot or streak
Boethoos distinguenda.
 c. Black, variegated with white.....*Boethoos reticulata*.
 d. Brown, with the dorsum depressed behind the middle
Boethoos globosa.
- (51) 52. Ground colour green, or sordid white.
 a. Hairy, and broadly marked across the dorsum with chestnut
Vanduzee testudinea.
 b. Very small: colour green or sometimes brown..*Aphetea affinis*.
- (1) 53. Posterior tarsi much shorter than the other pairs (Holophorinae).
- (55) 54. Wing with four apical cells: horn projecting forwards: colour brown
Aconophoroides gladiator.
- (54) 55. Wing with three apical cells: horn situated on the middle of dorsum: colour green.....*Umbonia spinosa*.
- B. Scutellum distinct, and more or less uncovered by the pronotum.
- (13) 1. Either or both the pronotum and scutellum armed with processes, crests, or carinae.
- (3) 2. Pronotum armed with a posterior process; scutellum unarmed.
 a. Posterior process of the pronotum lying close to the abdomen and extending almost to the apex of the latter: a pair of broad lateral processes above the shoulders
Centruchoides felinus.
 b. Posterior process long and styliform, remote from abdomen, and springing above the head from an erect process, which

is furnished in front with four black petiolated swellings.

Bocydium globulare.

- c. Posterior process short and spike-like, and hardly reaching half way along the abdomen. Size small: hind tibiae long, black, curved, and covered with minute regular spines

Ischnocentrus niger.

- (2) 3. Pronotum without a posterior process: scutellum unarmed.
(5) 4. Pronotum armed with two lateral processes in front: scutellum pale
Tolania scutata.

- (4) 5. Pronotum without lateral processes.
(7, 12) 6. Either or both the pronotum and scutellum provided with a pronounced median carina or crest. The hind tibiae long, curved and furnished with numerous minute spines.

(*Lophyraspis*, *Tropidaspis*.)

- (6, 12) 7. With a crest or crests.
(11) 8. Both pronotum and scutellum crested.
(10) 9. The crests sharp, high, recurved and bordered behind with white.
a. The two crests of equal height.....*Lophyraspis armata.*
b. The crest of the pronotum highest: size smaller

Lophyraspis pygmaea.

- (9) 10. The pronotal crests rounded and inclined forwards: not bordered with white behind: scutellum not crested but strongly carinate
Tropidaspis cornuta.

- (8) 11. The scutellum alone furnished with a crest, which is erect, compressed, and bordered with white behind. .*Lophyraspis fowleri.*

- (6) (7) 12. Pronotum and scutellum not crested but carinate.
a. Upper margin of the head sinuate....*Tropidaspis carinata.*
b. Upper margin of the head bi-lobed: size smaller

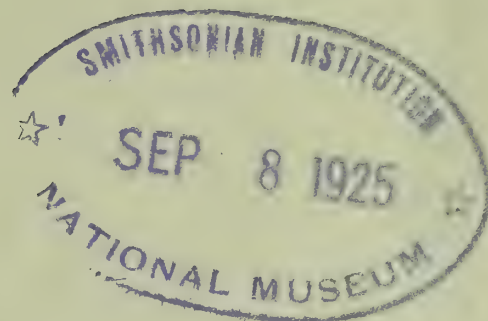
Tropidaspis minor.

- (1) 13. Pronotum and scutellum either completely unarmed, or at most faintly carinate.
a. Size rather large and square: colour brown: venation thickened and reticulate: legs without spines, and yellow, conspicuously spotted with black: upper margin of head almost flat.....*Aethalion reticulatum.*
b. Size very small and elongate: colour bronze black: tegmina opaque, but venation not reticulate: upper margin of head produced into two narrow lobes. .*Endoiastus productus.*

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University Pittsburgh

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THE TERMITES OF KARTABO*¹
BARTICA DISTRICT, BRITISH GUIANA

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(Figs. 24-94 incl.)

OUTLINE

INTRODUCTION

HISTORICAL SUMMARY

COMPARATIVE STATISTICS OF TERMITES

STATISTICAL SUMMARY

LOCALITIES (Approximate Position)

DISTRIBUTION

CLASSIFICATION

NEW SPECIFIC AND SUBGENERIC NAMES

MEASUREMENTS AND TERMS

SPECIES RECORDED; BRITISH GUIANA

USE OF KEY: BRITISH GUIANA TERMITES

KEY: BRITISH GUIANA TERMITES

LIST OF SPECIES

DESCRIPTION OF SPECIES

BIBLIOGRAPHY

INTRODUCTION

The material upon which the following report is based was largely collected by the author during three successive trips to British Guiana, the first from March to October 1919, the second from May to December 1920 and the third from February to September 1924. Practically the entire time was spent at the Tropical Research Station of the New York Zoological Society at Kartabo, British Guiana, sixty miles from the coast in the midst of the luxuriant tropical rain forest. I made the attempt to survey the termite life in the immediate neighborhood of the Research Station thoroughly, but so many new problems greeted me at every turn that I only partially succeeded. I do believe, however, that the majority of the species of termites in the vicinity were collected, so that the

* Thesis presented to the faculty of the Graduate School of Cornell University in partial fulfillment for the degree of Doctor of Philosophy.

¹ Contribution, Department of Tropical Research No. 193.

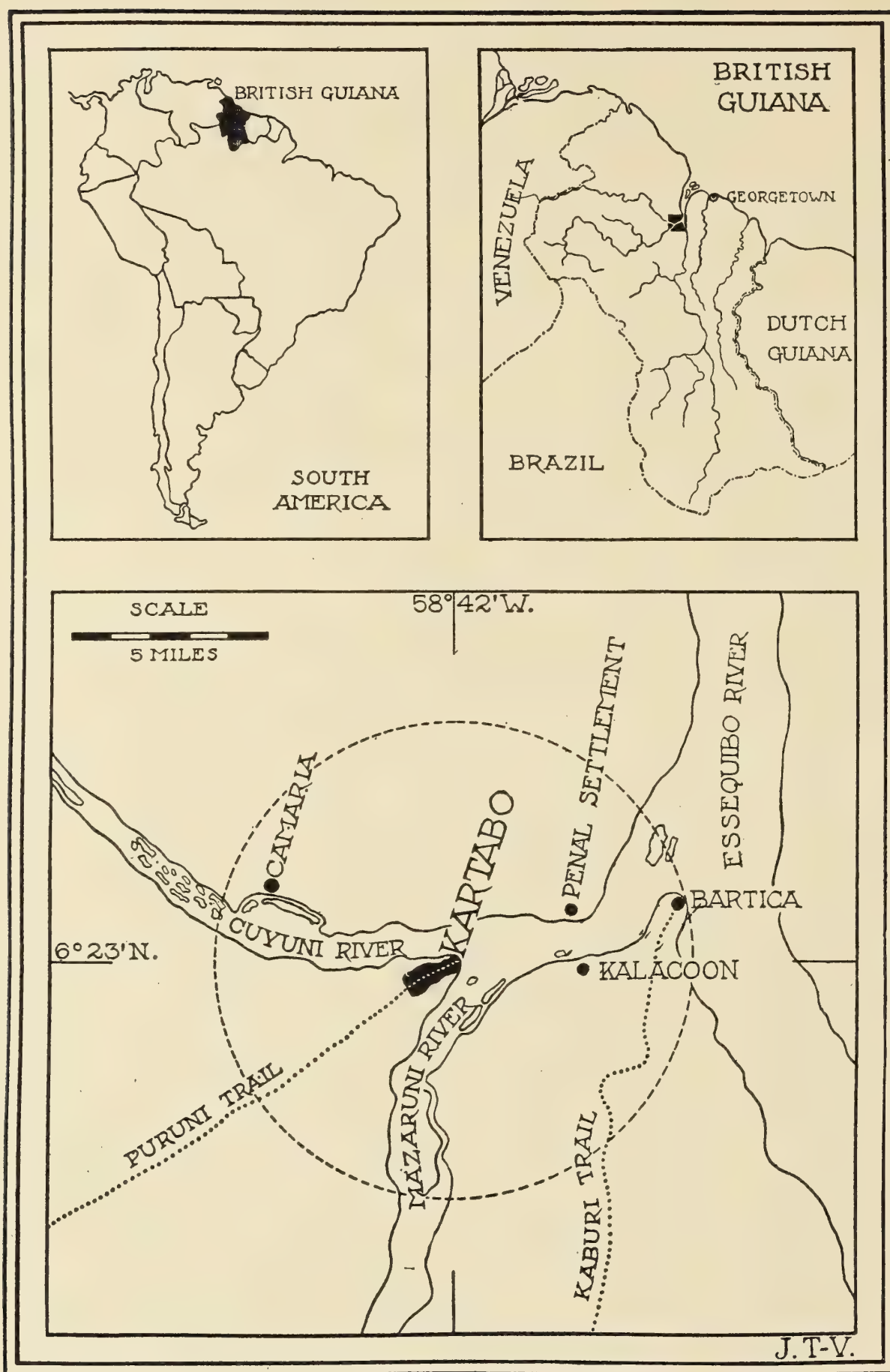


Plate A. British Guiana Tropical Research Station of the New York Zoological Society.
Circle represents a radius of six miles.

systematic report should be fairly complete for the locality. I imagine that the more arid savannah regions of British Guiana will prove in time to possess a somewhat different fauna.

My work was primarily of an ecological and biological nature, but the need for a thorough systematic account of the species was imperative. Preceding this report, numerous papers have appeared on the life of the termites and their guests with systematic and morphological accounts of the termitophiles which proved to be abundant in the nests of certain genera. [Brues (1923), Chamberlin (1923), Folsom (1923), Mann (1923), McIndoo (1923), Morrison (1923), Silvestri (1923).] Other papers are in preparation.

The material collected at Kartabo has been supplemented by valuable collections made in British Guiana by Dr. F. M. Gaige of the Museum of Zoology at Ann Arbor, Mr. G. E. Bodkin and Mr. L. D. Cleare, Jnr. of the Department of Agriculture of British Guiana, Mr. William Beebe, the director of the Tropical Research Station of the New York Zoological Society, Mr. John Tee-Van of the staff of the Tropical Research Station and Dr. William M. Wheeler and Dr. I. W. Bailey of Bussey Institution. I have also included records of a number of British Guiana species which I collected in the West Indian Islands on trips to and from British Guiana.

For continued helpful criticism and suggestions during the time spent in the field I am greatly indebted to Mr. Beebe, to whom I owe the opportunity for this study and to Prof. Wheeler, who was a constant source of inspiration during the few months in which he studied ants at Kartabo.

I am also indebted to Prof. J. C. Bradley and Prof. O. A. Johannsen of Cornell University and to Dr. T. E. Snyder of the U. S. Bureau of Entomology for criticism of the manuscript. Both in the field and in the preparation of the manuscript I was greatly helped by my wife, Winifred Jelliffe Emerson.

In the course of my studies I have examined the collections of termites at the Museum of Comparative Zoology, the American Museum of Natural History and the United States National Museum.

The collection of type specimens is deposited with the New York Zoological Society. Duplicate specimens and paratypes are deposited with the American Museum of Natural History, New York City, U. S. National Museum, Washington, and with the ento-

mological collection of Cornell University.

HISTORICAL SUMMARY.

The first termites to be reported from British Guiana were *Termes decumanus* (= *Syntermes grandis*) and *Termes morio* (= *Coptotermes testaceus*) by Erichson (1848) in Schomburk's "Reisen in Britisch-Guiana." Walker (1853) reported *Syntermes grandis* and *Syntermes dirus*. Hagen (1858) included *Coptotermes testaceus* and *Anoplotermes cingulatus* in the fauna. No collection of any importance was reported upon from British Guiana until Banks (1918) identified a collection made by F. E. Lutz which included eight species determined by Banks as *Leucotermes tenuis*, *Rhinotermes marginalis*, *Cornitermes acignathus*, *Nasutitermes ephratae*, *Nasutitermes guayanae*, *Nasutitermes holmgreni*, *Nasutitermes octopilis*, and *Capritermes cingulatus*. Recently Silvestri (1923) has described four more species, *Syntermes parallelus*, *Capritermes bodkini*, *Hamitermes excellens*, and *Eutermes parvulus*, making sixteen species in all reported from this locality. My collections include all except three of these species. Two (*Coptotermes testaceus* and *Anoplotermes cingulatus*) have been so inadequately described that their determination is practically impossible. *Syntermes grandis*, however, is a well described form and occurs within the borders of British Guiana, although I did not collect it. The British Guiana forms referred to *Syntermes dirus* probably belong to *S. snyderi*. All of the rest formerly reported from British Guiana are described in this report with the following changes in the names:—*Cornitermes acignathus* as reported by Banks is identical with *Cornitermes pugnax*, sp. nov.; the name of *Nasutitermes holmgreni* has been changed to *Nasutitermes banksi*; specimens determined by Banks as *Capritermes cingulatus* are probably the same as *Capritermes angusticeps*, sp. nov.; *Hamitermes excellens* is referred to as *Amitermes excellens* and *Eutermes parvulus* is referred to as *Nasutitermes* (*Subulitermes*) *parvulus*.

My collections add 15 formerly described species to the fauna and 51 species in the collections seem to be new to science, making in all a total of 81 species reported from British Guiana.

COMPARATIVE STATISTICS ON TERMITES

Number of known families	4
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Number of families found in British Guiana.....	3
Number of known genera and subgenera.....	118
Number of known neotropical genera and subgenera.....	41
Number of known British Guiana genera and subgenera..	30
Number of described species of the World.....	1094
Number of described species from the New World.....	292
Number of described Neotropical species.....	263
Number of described British Guiana species.....	81

STATISTICAL SUMMARY OF THIS REPORT

Number of species described from British Guiana.....	78
Number of species found at Kartabo.....	74
Number of species found in Bartica District.....	76
Number of species in this report formerly described.....	27
Number of species in this report new to science.....	51
Number of subgenera in this report new to science.....	3
Number of species in this report formerly known from only one caste, or castes described separately.....	16
Number of formerly known species to which a caste has been added or separately described castes connected..	14
Number of species in this report for which the imago and soldier if it exists are known (<i>Anoplotermes</i> included)..	66
Number of species in this report for which only the imago or soldier is known (excluding <i>Anoplotermes</i>).....	12

LOCALITIES MENTIONED

Approximate Position

- Amatuk, B. G. 59° 18' W., 5° 18' N.
- Antigua, W. I. 61° 40'–61° 50' W., 17°–17° 10' N.
- Arepo Savanna, Trinidad.
- Asuncion, Paraguay. 57° 30' W., 25° 25' S.
- Barakara, B. G. 58° 41' W., 6° 23' N.
- Bartica, B. G. 58° 38' W., 6° 24' N.
- Camaria, B. G. 58° 48' W., 6° 25' N.
- Canister Falls, B. G. 58° 30' W., 4° 54' N.
- Carabaya Mts., Peru. 70° W., 14° S.
- Castries, St. Lucia, W. I. 61° W., 14° N.
- Chaquimayo, Peru. Near 71° W., 14° S.

- Cow Island, B. G. 58° 38' W., 6° 25' N.
Coxipo (Cuyaba), Brazil. 56° W., 15° 30' S.
Cuyuni River. 58° 41'–61° 45' W., 5° 45'–7° N.
Dominica, W. I. 61° 10'–61° 30' W., 15° 10'–15° 40' N.
Dunoon, B. G. 58° 18' W., 6° 25' N.
Ephrata, Surinam. 54° 40' W., 10° N.
Fort de France, Martinique, W. I. 61° 5' W., 14° 40' N.
Georgetown, B. G. 58° 10' W., 6° 50' N.
Grenada, W. I. 61° 34'–61° 50' W., 12°–12° 16' N.
Issororo River, B. G. 58° 53'–59° 8' W., 7° 10'–7° 16' N.
Kaieteur Falls, B. G. 59° 27' W., 5° 11' N.
Kartabo, B. G. 58° 42' W., 6° 23' N.
Martinique, W. I. 60° 50'–61° 12' W., 14° 25'–14° 55' N.
Mazaruni River, B. G. 58° 38'–60° 42' W., 5° 31'–6° 26' N.
Mojos (Prov. Caupolican), Bolivia. 69° 10' W., 13° 45' S.
Montserrat, W. I. 62° 20' W., 16° 40' N.
Onderneeming, B. G. 58° 28' W., 7° 5' N.
Penal Settlement, B. G. 58° 40' W., 6° 24' N.
Port of Spain, Trinidad. 61° 25' W., 10° 42' N.
Potaro Landing, B. G. 59° 9' W., 5° 23' N.
Potaro River, B. G. 58° 52'–59° 53' W., 4° 58'–5° 25' N.
St. Croix, W. I. 64° 35'–65° W., 17° 40'–17° 45' N.
St. Jose de Marabitanas, Brazil. 66° 40' W., 0° 55' N.
St. Joseph, Trinidad. 61° 23' W., 10° 40' N.
St. Kitts, W. I. 62° 35'–62° 50' W., 17° 10'–17° 25' N.
St. Lucia, W. I. 60° 50'–61° 5' W., 13° 45'–14° 5' N.
St. Thomas, W. I. 64° 50'–65° W., 18° 20'–18° 25' N.
Sanchez, Dominican Republic. 69° 40' W., 19° 20' N.
Santarem, Brazil. 54° 20' W., 2° 30' S.
Santiago, Dominican Republic. 70° 40' W., 19° 30' N.
Taboga Island, Panama. 79° 25' W., 8° 55' N.
Tuiche River (Prov. Caupolican), Bolivia. 67° 25'–68° 40' W.,
13° 20'–15° S.
Tukeit, B. G. 59° 25' W., 5° 13' N.
Tumatumari, B. G. 59° 25' W., 5° 22' N.
Union, St. Lucia, W. I. Near Castries.
Wenamu River. 61° 8'–61° 21' W., 5° 57'–6° 42' N.

DISTRIBUTION

A number of genera of termites are found in all the warmer parts of the world showing a rather ancient history which, when studied carefully may give some interesting clues to the larger problems of distribution. The groups which have been reported from the Australian, Oriental, Ethiopian and Neotropical Regions are *Kaloterme*s, s. str., *Neoterme*s, *Cryptoterme*s, *Glyptoterme*s, *Pro-rhinoterme*s, *Coptoterme*s, *Nasutiterme*s, s. str., *Subuliterme*s, *Ami-terme*s, s. str., *Mirotérme*s, s. str., and *Microceroterme*s.

The faunas of Africa, Madagascar and the Oriental Region are more closely related than any of these regions are to South America. The South American termite fauna is more closely related to the Ethiopian and Oriental than to the Australian Region.

Following is a list of the groups which so far have been reported only from the New World:

*Rugiterme*s, *Eucryptoterme*s, *Rhinoterme*s, s. str., *Serriterme*s, *Synterme*s, *Corniterme*s, s. str., *Armiterme*s, *Convexitérme*s, *Diversi-terme*s, *Velociterme*s, *Constrictoterme*s, *Angulariterme*s, *Cylindro-terme*s, *Crepiditerme*s, *Caviterme*s, *Spiniterme*s, and *Orthognathoterme*s.

Many of these groups are small, but the larger ones are significant in their distribution.

In working over the collections of British Guiana termites I have been impressed with certain obvious relationships to the surrounding regions. The island of Trinidad possesses many species identical with those found in British Guiana and the West Indies show a number of species which correspond to British Guiana species. The fauna of Panama, however, seems to be quite different, the only species that are common to the two regions being those of wide distribution such as *Coptoterme marabitanas* and *Leucoterme tenuis*. Many of the forms described from Peru and Bolivia by Holmgren are very close to the British Guiana forms, but often differ by specific or subspecific characters which are very slight. The fauna from southern South America described by Silvestri (1903), however, seems to be much more distinct from that of British Guiana than is the Peruvian and Bolivian fauna. A study of the Amazon basin should give us many connecting links between British Guiana and western and southern South America but unfortunately little is yet known concerning the termites of this region.

CLASSIFICATION

After having nearly completed the manuscript of this report, I received two papers by S. F. Light (1921 & 1921a) which admirably set forth many of my own views on termite classification. It is a great pleasure to find another new student of this group who has independently arrived at the same conclusions with regard to many rather complicated systematic problems.

In general I have followed Holmgren's classification (1911 & 1912) as it is certainly the best yet introduced for the termites of the world. However, as Light and Banks have pointed out, certain of Holmgren's names are not based upon the generally accepted rules of nomenclature and I prefer to follow Light in the family names. I have followed Banks (Banks & Snyder, 1920) in retaining the old spelling of *Kaloterme*s and have also used the name *Nasutitermes* for the old genus *Eutermes* Fritz Müller, retaining *Microcerotermes*, however, as explained in the pages following.

I am also of the opinion that *Prorhinotermes* should replace *Arrhinotermes* as used by Holmgren and that *Termes* should replace *Odontotermes* as used by Holmgren, as Banks has already suggested. *Termes fatalis* Linnaeus, although probably impossible to determine as a modern species, seems to belong to Holmgren's *Odontotermes* with some doubt, as he himself has pointed out (1912). If *T. fatalis* Linn. cannot be considered the type, then *T. capensis* is type, according to Holmgren, 1912 and Fuller, 1921, p. 17. Holmgren's subgenus *Macrotermes* has been made to include the entire genus *Termes* of Holmgren. This leaves Holmgren's subgenus *Termes* without a name and I propose a new name *Bellicositermes* for this subgenus with *Macrotermes (Bellicositermes) bellicosus* Smeathman as the type species.

Light has thought it best to raise many of Holmgren's subgeneric groups to generic rank. Silvestri (1914) and Banks (Banks & Snyder, 1920) have also largely dropped the use of subgeneric names. I agree heartily with these authors that the use of subgeneric names is cumbersome, but feel that many of Holmgren's subgenera need further study before raising them all to generic rank and I do not believe that a few should be raised to generic rank without publishing a list of world species and genera. Arbitrarily raising all of Holmgren's subgenera to genera would certainly cause confusion, especially in such groups as *Nasutitermes*, where many of the sub-

genera are not yet fully established. I have therefore retained most of Holmgren's generic and subgeneric names with the belief that at present such a procedure will cause less confusion.

New Specific and Subgeneric Names

(Proposed for formerly described species and subgenera)

Bellicositermes to take the place of *Termes*, s. str. as used by Holmgren (1912).

Type species: *Macrotermes* (*Bellicositermes*) *bellicosus* (Smeathman).

Nasutitermes (*N.*) *banksi*, new name for *Nasutitermes holmgreni* Banks.

Nasutitermes (*Subulitermes*) *thompsonae*, new name for *Eutermes incola* Holmgren.

Anoplotermes (*A.*) *meridianus*, new name for *Anoplotermes morio* (Latr.) Silvestri.

The reasons for these changes will be found elsewhere in the paper.

MEASUREMENTS AND TERMS

Following Light's suggestion, I believe that an explanation of some of the terms used in describing the forms in this report which might be misinterpreted may save confusion.

Bristles.—Long, relatively stiff hairs found on head, thorax, and abdomen. I have usually used this term to contrast the longer hairs with the shorter hairs when they are found together. The term is thus comparative.

Cilia.—The short hairs often found on the margins of the wings.

Constriction.—A narrowed region running across the top and sides of the head. This term is used particularly in the description of the soldiers of *Nasutitermes*.

Costal margin.—The thickened vein-like margin found on nearly all termite wings.

Cubitus.—The large inner vein of the wing which, in termites, always has a number of parallel branches running to the inner margin.

Diameter of eye.—The widest part of the compound eye.

Eye.—Used to designate the compound eye.

Fontanelle.—The opening of the frontal gland. This term is also used for the fontanelle plate as defined by Light (1921a).

Frontal tube.—A short projection with the opening of the frontal gland at the end, usually found in *Syntermes* and *Cornitermes*. This structure is homologous with the nose of *Armitermes* and *Nasutitermes*.

Holotype.—I use this term to designate the single specimen upon which the species is based. It may be either the soldier or imago, usually depending upon which shows the most clean-cut specific characters.

Imago.—This term is used for any first form reproductive individual whether a king, queen, or winged specimen.

Length of anterior wing.—Taken from the suture to the tip.

Length of head.—In imago, used to measure from the back of the head to the tip of the labrum; in the soldier with mandibles, from the tip of the mandibles to the back of the head; in the soldier without mandibles, from the tip of the nose to the back of the head.

Length of head without mandibles.—Taken from the back of the head to the tip of the labrum.

Length of pronotum.—Always measured at the median line whether the margins are emarginate or not.

Major soldier.—The largest soldier form in those species with polymorphic soldiers.

Media.—The vein between the radius and cubitus.

Minor soldier.—The smallest soldier form in those species with polymorphic soldiers.

Morphotype.—A single specimen of the caste (usually a soldier or imago) which has not been designated as the Holotype. In every case the single specimen is from the same colony as the Holotype.

Muscle insertions:—A term used by Holmgren to indicate certain areas visible from the outside which usually form spots of a

lighter color in back of the postclypeus. Presumably muscles are attached to the chitin at these points.

Nose:—The projection in front of the head in the soldiers of certain genera.

Nymph:—I follow Comstock in calling all immature forms of termites nymphs.

Postclypeus or posterior clypeus.—The posterior sclerite of the clypeus. In termites the clypeus is usually divided into two parts, the anteclypeus in the imago usually being white and the postclypeus pigmented with or without a median longitudinal suture.

Radius.—The vein which runs close to the costal margin from the suture to the tip of the wing. In all except certain species of *Kaloterme*s it is unbranched and thickened.

Scale.—This term is used to designate that part of the wing behind the suture which remains on the sexual forms after the wings are shed.

Vertex.—The dorsal posterior portion of the head.

Width of head.—Taken at widest point. In the imago it always includes the eyes.

SPECIES RECORDED: BRITISH GUIANA

Kalotermes (**Neoterme**s) **clearei**, sp. nov.

Kalotermes (**Neoterme**s) **kartaboensis**, sp. nov.

Kaloterme (*Neoterme*) *holmgreni* Banks

Kalotermes (**Rugiterme**s) **bicolor**, sp. nov.

Kalotermes (**Rugiterme**s) **flavicinctus**, sp. nov.

Kalotermes (**Rugiterme**s) **magninotus**, sp. nov.

Kaloterme (*Cryptoterme*) *brevis* (Walker)

Kalotermes (**Cryptoterme**s) **verruculosus**, sp. nov.

Kalotermes (**Cryptoterme**s ?) **cubicocephus**, sp. nov.

Kalotermes (**Glyptoterme**s) **pellucidus**, sp. nov.

Kalotermes (**Glyptoterme**s) **perparvus**, sp. nov.

Kalotermes (**Glyptoterme**s) **guianensis**, sp. nov.

Kalotermes (**Glyptoterme**s) **hospitalis**, sp. nov.

Kalotermes (**Lobiterme**s) **nigriceps**, sp. nov.

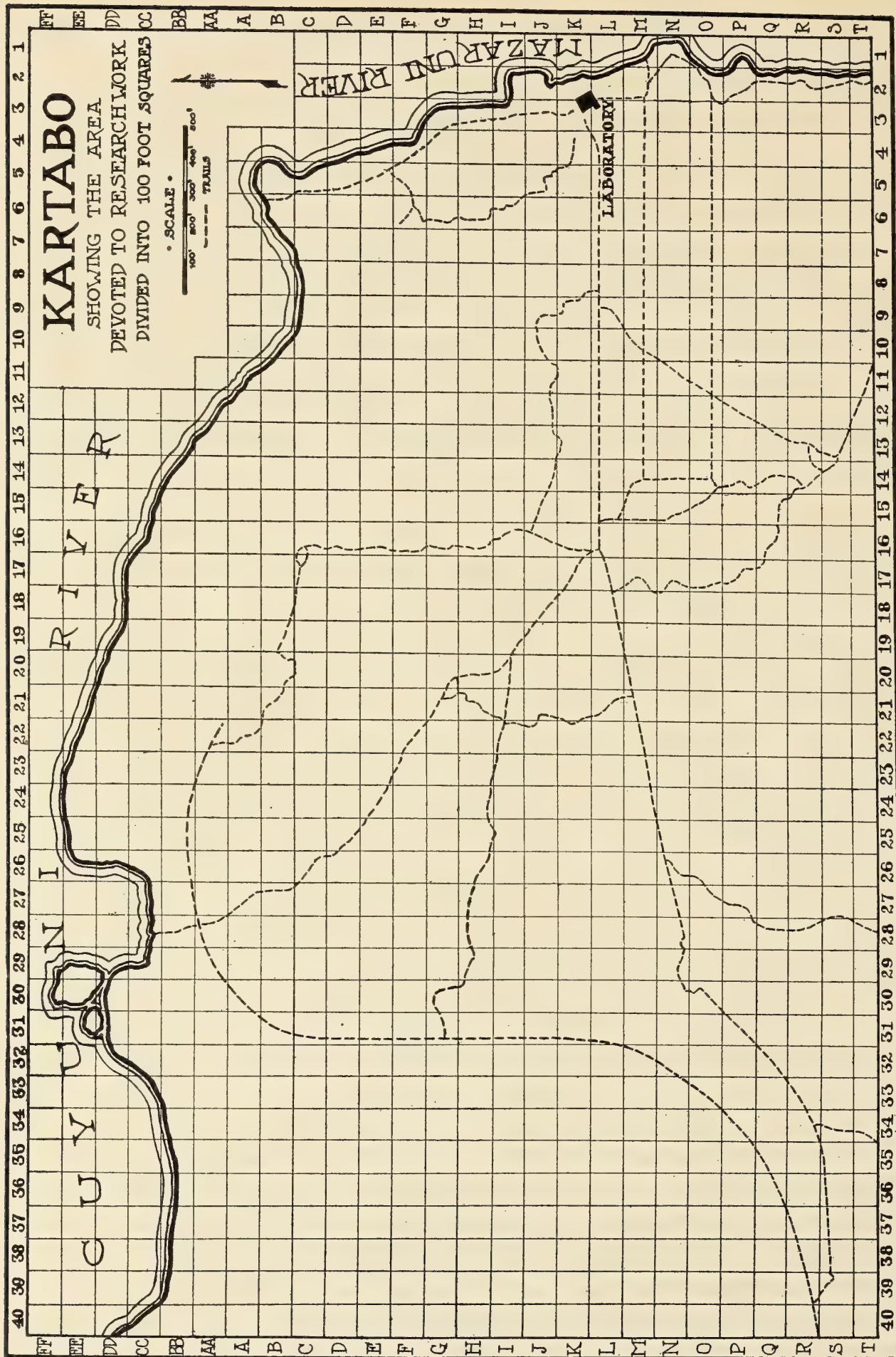


Plate B. Area devoted to research at Kartabo.

Drawing by John Tee-Van.

Leucotermes tenuis (Hagen)

Leucotermes crinitus, sp. nov.

Coptotermes marabitanas (Hagen)

**Coptotermes testaceus* (Linn.) (doubtful species)

Rhinotermes (*Rhinotermes*) *nasutus* (Perty)

Rhinotermes (*Rhinotermes*) *marginalis* (Linn.)

Rhinotermes (**Rhinotermes**) *hispidus*, sp. nov.

Rhinotermes (**Rhinotermes**) *longilabius*, sp. nov.

Rhinotermes (**Rhinotermes**) *tenebrosus*, sp. nov.

Rhinotermes (**Rhinotermes**) *subfusciceps*, sp. nov.

Syntermes snyderi, sp. nov.

Syntermes territus, sp. nov.

**Syntermes grandis* (Rambur)

Syntermes parallelus Silvestri

Cornitermes (*Labiotermes*) *labralis* Holmgren

Cornitermes (**Cornitermes**) *pugnax*, sp. nov.

Armitermes (*Armitermes*) *albidus* (Hagen)

Armitermes (**Armitermes**) *percutiens*, sp. nov.

Armitermes (**Armitermes**) *teevani*, sp. nov.

Armitermes (**Armitermes**) *grandidens*, sp. nov.

Armitermes (**Armitermes**) *minutus*, sp. nov.

Nasutitermes (*Nasutitermes*) *guayanae* (Holmgren)

Nasutitermes (*Nasutitermes*) *costalis* (Holmgren)

Nasutitermes (*Nasutitermes*) *ephratae* (Holmgren)

Nasutitermes (*Nasutitermes*) *octopilis* Banks

Nasutitermes (*Nasutitermes*) *surinamensis* (Holmgren)

Nasutitermes (*Nasutitermes*) *acajutlae* (Holmgren)

Nasutitermes (*Nasutitermes*) *intermedius* Banks

Nasutitermes (**Nasutitermes**) *comstockae*, sp. nov.

Nasutitermes (**Nasutitermes**) *wheeleri*, sp. nov.

Nasutitermes (*Nasutitermes*) *banksi*, new name

Nasutitermes (**Nasutitermes**) *gaugei*, sp. nov.

Nasutitermes (**Nasutitermes**) *brevipilus*, sp. nov.

Nasutitermes (**Subulitermes**) *baileyi*, sp. nov.

Nasutitermes (*Subulitermes*) *parvulus* (Silvestri)

Nasutitermes (**Subulitermes**) *oculatissimus*, sp. nov.

Nasutitermes (**Subulitermes**) *raripilus*, sp. nov.

Nasutitermes (**Subulitermes**) *osborni*, sp. nov.

Nasutitermes (**Subulitermes**) *snyderi*, sp. nov.

Nasutitermes (*Convexitermes*) *nigricornis* (Holmgren)

- Nasutitermes** (**Convexitermes**) **kartaboensis**, sp. nov.
Nasutitermes (**Convexitermes**) **mazaruniensis**, sp. nov.
Nasutitermes (**Convexitermes**) **manni**, sp. nov.
Nasutitermes (**Velocitermes**) **beebei**, sp. nov.
Nasutitermes (*Constrictotermes*) *cavifrons* (Holmgren)
Nasutitermes (**Angularitermes**) **nasutissimus**, sp. nov.
Anoplotermes (**Anoplotermes**) **silvestrii**, sp. nov.
Anoplotermes (**Anoplotermes**) **banksi**, sp. nov.
Anoplotermes (**Anoplotermes**) **brevipilus**, sp. nov.
Anoplotermes (**Anoplotermes**) **subterraneus**, sp. nov.
Anoplotermes (**Anoplotermes**) **nigripunctatus**, sp. nov.
 **Anoplotermes* (*Anoplotermes*) *cingulatus* (Burmeister) (doubtful species)
Anoplotermes (**Speculitermes**) **arboreus**, sp. nov.
Cylindrotermes nordenskiöldi Holmgren
Amitermes (*Amitermes*) *excellens* Silvestri
Mirotermes (**Crepititermes**) **verruculosus**, sp. nov.
Mirotermes (*Mirotermes*) *nigritus* (Silvestri)
Mirotermes (*Mirotermes*) *hispaniolae* Banks
Mirotermes (**Mirotermes**) **acutinasus**, sp. nov.
Mirotermes (**Mirotermes**) **inquilinus**, sp. nov.
Mirotermes (**Cavitermes**) **tuberosus**, sp. nov.
Mirotermes (*Spinitermes*) *trispinosus* (Bates)
Capritermes (*Neocapritermes*) *bodkini* Silvestri
Capritermes (**Neocapritermes**) **angusticeps**, sp. nov.
Capritermes (**Neocapritermes**) **planiceps**, sp. nov.
Orthognathotermes macrocephalus (Holmgren)
Microcerotermes arboreus, sp. nov.

Species marked with an (*) are not described in this report.

USE OF KEY: BRITISH GUIANA TERMITES

The following key to the species of termites found in British Guiana is made for ease in determination. Where systematic arrangement could be followed without sacrificing simplicity, I have done so.

Explanation.—If the student has procured both the imago (king, queen or winged adult) and the soldier, he will find it easier to determine the species by starting at 2.

If he has only soldiers before him he should start at 70. In

this case the key often will refer to preceding numbers.

If he has only the imago and is reasonably certain that soldiers did not exist in the colony, he should start with 2. A single genus, *Anoplotermes*, lacks soldiers, the imago being told from related groups by the presence of deep narrow notches on the posterior margins of the meso- and metanota.

I have not included a key for the determination of the imagos alone, because they are very difficult to determine in this way, the keys usually being unsatisfactory even for the specialist in the group.

With this key and the descriptions and figures for help, even an inexperienced person should be able to determine the species so far reported from British Guiana.

Accuracy of measurement is absolutely necessary. The measurements used here were made with a micrometer disc in the eyepiece of the microscope.

KEY: BRITISH GUIANA TERMITES

1. Imago, soldier (when present), and worker procured.....2.
Only the soldier procured.....70.
2. Scale of forewing of imago much larger and usually overlapping
scale of hindwing.....3.
Scale of forewing of imago only slightly larger and never over-
lapping scale of hindwing.....18.
3. Clypeus of imago projecting, forming a conspicuous nose-like
structure.....4.
Clypeus of imago not projecting conspicuously.....8.
4. Head of minor soldier conspicuously constricted behind; anterior
margin of pronotum projecting forward; head darker than
rest of body. *Rhinotermes* (*R.*) *subfusciceps*, sp. nov. p. 356.
Head of minor soldier not conspicuously constricted behind.....5.
5. Labrum of major soldier wide.....6.
Labrum of major soldier narrow.....7.
6. Right mandible of major soldier with two teeth. *Rhinotermes*
(*R.*) *hispidus*, sp. nov. p. 350.
Right mandible of major soldier with one tooth. *Rhinotermes*
(*R.*) *marginalis* (L.) Hagen. p. 349.
7. Right mandible of major soldier with 2 large separated teeth.
Rhinotermes (*R.*) *tenebrosus*, sp. nov. p. 354.
Right mandible of major soldier with a large double-pointed tooth.
Rhinotermes (*R.*) *longilabius*, sp. nov. p. 351.
8. Head of soldier proportionately long, brownish or yellowish;
mandibles normal.....9.
Head of soldier proportionately short, partially or entirely black;
mandibles short.....16.

9. Mandibles of soldier without teeth except near base.....10.
Mandibles of soldier with conspicuous teeth along the inner margin.....12.
10. Soldier with large conspicuous opening to frontal gland at base of clypeus; head proportionately wide, narrowing toward front.
Coptotermes marabitanas (Hagen) p. 345.
Soldier without conspicuous opening to frontal gland; head proportionately long with sides nearly parallel.....11.
11. Head of soldier sparsely covered with hair; anterior angles of pronotum rounded. *Leucotermes tenuis* (Hagen) p. 341.
Head of soldier thickly covered with hair; anterior angles of pronotum sharp. *Leucotermes crinitus* sp. nov. p. 343.
12. Forehead of soldier deeply lobed and steep.....13.
Forehead of soldier not deeply lobed; front sloping at an angle of about 45°.....14.
13. Small species; width of head of soldier .76-.84 mm. *Kalotermes* (*Glyptotermes*) *perparvus*, sp. nov. p. 334.
Larger species; width of head of soldier 1.18-1.25 mm. *Kalotermes* (*Glyptotermes*) *guianensis*, sp. nov. p. 335.
14. Antennae of soldier with 11 or 12 segments, 3d segment shorter than 2d. *Kalotermes* (*Glyptotermes*) *hospitalis*, sp. nov. p. 336.
Antennae of soldier with 15-17 segments, 3d segment longer than 2d.....15.
15. Large species; width of head of soldier 2.71-2.76 mm. *Kalotermes* (*Neotermes*) *clearei*, sp. nov. p. 318.
Width of head of soldier 1.80-2.07 mm. *Kalotermes* (*Rugitermes*) *bicolor*, sp. nov. p. 322.
Width of head of soldier 1.38-1.48 mm. *Kalotermes* (*Rugitermes*) *magninotus*, sp. nov. p. 325.
Width of head of soldier 1.19-1.35 mm. *Kalotermes* (*Rugitermes*) *flavicinctus*, sp. nov. p. 324.
16. Forehead of soldier conspicuously tuberculate.....17.
Forehead of soldier not tuberculate. *Kalotermes* (*Lobitermes*) *nigriceps*, sp. nov. p. 338.
17. Top of head of soldier tuberculate for about $\frac{3}{4}$ its length; anterior margin of the pronotum concave. *Kalotermes* (*Cryptotermes*) *brevis* (Walker) p. 327.
Top of head of soldier tuberculate for nearly $\frac{1}{2}$ its length; anterior margin of pronotum emarginate. *Kalotermes* (*Cryptotermes*) *verruculosus*, sp. nov. p. 329.
Top of head of soldier not tuberculate; anterior margin of pronotum emarginate. *Kalotermes* (*Cryptotermes*?) *cubicoceps*, sp. nov. p. 331.
18. Colonies without soldiers; posterior margins of meso- and meta-nota narrowly and deeply emarginate.....19.
Colonies with soldiers.....23.
19. Width of head of imago 1.44-1.67 mm.; fontanelle much larger than ocelli, circular; 3d antennal segment equal to the 4th.....20.

- Width of head of imago 1.06–1.16 mm.; fontanelle darker than head; 3d antennal segment smaller than the 4th. *Anoplotermes* (A.) *nigripunctatus*, sp. nov. p. 427.
- Width of head of imago .73–.90 mm.; fontanelle lighter than head; 3d antennal segment smaller than 4th.....21.
20. Width of pronotum of imago about 1.61 mm.; workers with dark heads. *Anoplotermes* (*Speculitermes*) *arboreus*, sp. nov. p. 428.
- Width of pronotum of imago 1.33–1.40 mm.; workers with light heads. *Anoplotermes* (A.) *silvestrii*, sp. nov. p. 422.
21. Fontanelle of imago about as large as the ocelli, light and conspicuous; width of head .83–.87 mm. *Anoplotermes* (A.) *subterraneus*, sp. nov. p. 425.
- Fontanelle of imago small and inconspicuous.....22.
22. Length of hind tibia .63–.73 mm. *Anoplotermes* (A.) *brevipilus*, sp. nov. p. 424.
- Length of hind tibia .83–.97 mm. *Anoplotermes* (A.) *banksi*, sp. nov. p. 423.
23. Mandibles of soldier degenerate, not functional; front of head prolonged into a conspicuous nose.....25.
- Mandibles of soldier well developed.....24.
24. Front of head of soldier prolonged into a conspicuous nose reaching nearly to or beyond the end of the mandibles.....51.
- Front of head of soldier not prolonged into a nose that nearly reaches the end of the mandibles or beyond.....54.
25. Head of soldier with conspicuous constriction in the middle; legs proportionately very long, the hind tibia usually being longer than the head.....26.
- Head of soldier with a slight constriction in the middle; legs not proportionately long, the hind tibia always conspicuously shorter than the head.....28.
- Head of soldier with no constriction in the middle; legs not proportionately long, the hind tibia always conspicuously shorter than the head.....31.
26. Nose of soldier very large and long, covered with short hairs. *Nasutitermes* (*Angularitermes*) *nasutissimus*, sp. nov. p. 420.
- Nose of soldier comparatively slender, hairs only on the tip.....27.
27. Antennae of soldier with 15 segments; length of head 1.56–1.70 mm. *Nasutitermes* (*Constrictotermes*) *cavifrons* (Holm.) p. 419.
- Antennae of soldier with 13–14 segments; length of head 1.25–1.50 mm. *Nasutitermes* (*Velocitermes*) *beebei*, sp. nov. p. 416.
28. Head of soldier with only 6 bristles and no short hair.....29.
- Head of soldier covered with short hairs and a few bristles. *Nasutitermes* (*Subulitermes*) *snyderi*, sp. nov. p. 406.
29. Length of head of soldier 1.13–1.16 mm. *Nasutitermes* (*Subulitermes*) *oculatissimus*, sp. nov. p. 402.
- Length of head of soldier 1.22–1.38 mm.30.

30. Eye of imago very large, .43 mm. in diameter. *Nasutitermes* (*Subulitermes*) *osborni*, sp. nov. p. 404.
 Eye of imago medium sized, .30 mm. in diameter. *Nasutitermes* (*Subulitermes*) *raripilus*, sp. nov. p. 402.
 (Note: Soldiers of these two species are hard to distinguish.)
31. No hair on nose of soldier except at tip.....32.
 Nose of soldier sparsely covered with bristles or covered with minute hair.....43.
32. Top of head of soldier covered with short hair besides a few longer bristles.....42.
 Top of head and base of nose of soldier with bristles but short hair absent.....33.
33. 4 bristles near the base of the nose of soldier and 4 or more bristles on top of head.....40.
 4 bristles near base of nose of soldier and 2 bristles on top of head.....34.
34. Abdominal tergites of soldier covered with long hair in addition to longer bristles.....35.
 Abdominal tergites of soldier covered with minute hair and a row of longer bristles.....36.
35. Width of head of soldier .80–1.00 mm. *Nasutitermes* (N.) *comstockae*, sp. nov. p. 390.
 Width of head of soldier 1.10–1.22 mm. *Nasutitermes* (N.) *suri-namensis* (Holmgren) p. 386.
36. Antennae of soldier with 13 segments.....38.
 Antennae of soldier with 11 or 12 segments.....37.
37. Nose of soldier slender.....29.
 Nose of soldier stout. *Nasutitermes* (N.) *ephratae* (Holmgren) p. 382.
38. Small species, length of head of soldier 1.16–1.24 mm. *Nasutitermes* (N.) *gaigei*, sp. nov. p. 395.
 Larger species, length of head of soldier over 1.34 mm.....39.
39. Imago with ocelli less than their diameter from the eyes. *Nasutitermes* (N.) *ephratae* (Holmgren) p. 382.
 Imago with ocelli more than their diameter from the eyes. *Nasutitermes* (N.) *costalis* (Holmgren) p. 379.
 (Note: Soldiers of these two species are very hard to distinguish.)
40. Head of soldier yellow; 4 bristles at base of nose and 4 bristles on top of head. *Nasutitermes* (N.) *octopilis* Banks p. 384.
 Head of soldier brown; 4 bristles at base of nose and 6 or more on top of head.....41.
41. Antennae of soldier with 14 segments; nose stout. *Nasutitermes* (N.) *guayanae* (Holmgren) p. 378.
 Antennae of soldier with 13 segments; nose slender. *Nasutitermes* (N.) *intermedius* Banks p. 389.
42. Small species; length of head of soldier 1.06–1.26 mm. *Nasutitermes* (N.) *banksi*, n. name p. 393.
 Larger species; length of head of soldier 1.64–1.80 mm. *Nasutitermes* (N.) *wheeleri*, sp. nov. p. 391.

43. Head of soldier with no short hair besides the bristles on top of head.....29.
 Head of soldier with very short hair covering top of head and usually with a few longer bristles.....44.
 Head of soldier with proportionately longer hair covering top of head.....46.
44. Comparatively large species, length of head of soldier 1.33-1.70 mm.....45.
 Comparatively small species, length of head of soldier 1.03-1.12 mm. *Nasutitermes* (*Subulitermes*) *baileyi*, sp. nov. p. 399.
45. Profile of head of soldier from tip of nose to top of head concave. *Nasutitermes* (*N.*) *brevipilus*, sp. nov. p. 396.
 Profile of head of soldier from tip of nose to top of head convex. *Nasutitermes* (*Convexitermes*) *manni*, sp. nov. p. 413.
46. Comparatively large species, length of head of soldier 1.73-1.83 mm.; antennae with 13 segments. *Nasutitermes* (*N.*) *acajutlae* (Holmgren) p. 388.
 Comparatively small species, length of head of soldier less than 1.35 mm.; antennae with 11 or 12 segments.....47.
47. Antennae of soldier with 12 segments. *Nasutitermes* (*Subulitermes*) *parvellus* (Silvestri) p. 400.
 Antennae of soldier with 11 segments.....43.
48. Nose of soldier conical; profile nearly convex from tip of nose to back of head, no constriction in the middle.....49.
 Nose of soldier straight and slender; profile not as above, a slight constriction in the middle of the head. *Nasutitermes* (*Subulitermes*) *snyderi*, sp. nov. p. 406.
49. Nose of soldier very stout at base; length of head 1.00-1.07 mm.....50.
 Nose of soldier not very stout at base, length of head 1.25-1.35 mm. *Nasutitermes* (*Convexitermes*) *nigricornis* (Holmgren) p. 409.
50. Nose of soldier dark brown; length of anterior wing of imago 7.70-7.87 mm. *Nasutitermes* (*Convexitermes*) *kartaboensis*, sp. nov. p. 410.
 Nose of soldier brown; length of anterior wing of imago 6.20-6.73 mm. *Nasutitermes* (*Convexitermes*) *mazaruniensis*, sp. nov. p. 412.
51. Mandibles of soldier extending beyond tip of nose; antennae with 14 segments. *Armitermes* (*A.*) *percutiens*, sp. nov. p. 370.
 Mandibles of soldier not reaching tip of nose.....52.
52. Antennae of soldier with 15 segments. *Armitermes* (*A.*) *teevani*, sp. nov. p. 372.
 Antennae of soldier with 13 or 14 segments.....53.
53. Large species, length of head of soldier 3.21-3.37 mm.; antennae with 14 segments. *Armitermes* (*A.*) *grandidens*, sp. nov. p. 373.
 Medium sized species, length of head of soldier 1.80-1.95 mm.; antennae with 13-14 segments. *Armitermes* (*A.*) *albidus* (Hagen) p. 368.
 Small species, length of head of soldier 1.50-1.54 mm.; antennae with 13 segments. *Armitermes* (*A.*) *minutus*, sp. nov. p. 375.
54. Mandibles of soldier extremely asymmetrical.....55

- Mandibles of soldier more or less symmetrical.....57.
55. Posterior margin of head of soldier lobed; head very flat. *Capritermes* (*Neocapritermes*) *planiceps*, sp. nov. p. 449.
Posterior margin of the head rounded; head not flat.....56.
56. Head of soldier long and narrow; sides parallel. *Capritermes* (*Neocapritermes*) *angusticeps*, sp. nov. p. 448.
Head of soldier proportionately wide, sides converging anteriorly. *Capritermes* (*Neocapritermes*) *bodkini* Silvestri p. 447.
57. Mandibles of soldier very slender, without teeth except at base; used for snapping.....58.
- Mandibles of soldier used for biting, usually powerful and toothed.....62.
58. Forehead of soldier flat without projection; antennae with 13 segments. *Mirotermes* (*Crepititermes*) *verruculosus*, sp. nov. p. 434.
Forehead of soldier with conspicuous projection or nose; antennae with 14 or 15 segments.....59.
59. Forehead and soldier with short conspicuous single-pointed nose without sharp ridge from point to base of antennae.....60.
- Forehead of soldier wide; projection with short point in middle and a distinct sharp ridge from point to base of antennae. *Mirotermes* (*Cavitermes*) *tuberosus*, sp. nov. p. 442.
60. Nose of soldier extending well beyond base of antennae; width of head .97 mm. *Mirotermes* (*M.*) *acutinasus*, sp. nov. p. 439.
Nose of soldier not extending much beyond antennae base.....61.
61. Width of head of soldier 1.30–1.45 mm. *Mirotermes* (*M.*) *inquilinus*, sp. nov. p. 441.
Width of head of soldier 1.09–1.16 mm. *Mirotermes* (*M.*) *hispaniolae* Banks p. 438.
Width of head of soldier .77–1.00 mm. *Mirotermes* (*M.*) *nigritus* (Silvestri) p. 436.
62. Forehead of soldier with 3-pointed projection. *Mirotermes* (*Spinitermes*) *trispinosus* (Bates) p. 444.
Forehead of soldier without 3-pointed projection.....63.
63. Mandibles of soldier sickle-shaped.....64.
- Mandibles of soldier elbowed, the anterior portion bent outward, tips curved inward; a single tooth on the inner edge at the elbow. *Orthognathotermes macrocephalus* (Holmgren) p. 452.
64. Pronotum of soldier with sharp lateral points; very large species.....65.
- Pronotum of soldier without sharp lateral points; medium sized or small species.....66.
65. Head of soldier thickly covered with short bristles; right mandible with a large tooth; width of head 6.74–6.85 mm. *Syntermes snyderi*, sp. nov. p. 359.
Head of soldier sparsely covered with short bristles; right mandible with no large teeth; width of head 4.75–4.96 mm. *Syntermes territus*, sp. nov. p. 360.
Head of soldier sparsely covered with bristles; right mandible with no large teeth; width of head 2.97–3.32 mm. *Syntermes parallelus* Silvestri. p. 361

66. The inner edges of the mandibles of the soldier with minute dentations. *Microcerotermes arboreus*, sp. nov. p. 454.
The inner edges of mandibles of soldier without minute dentations.....67.
67. Length of head of soldier with mandibles 2.01–2.33 mm.; mandibles short in relation to head; head proportionately long, sides parallel. *Cylindrotermes nordenskiöldi* Holm. p. 430.
Length of head of soldier with mandibles over 3.00 mm.....68.
68. Soldier with short tube projection on forehead; mandibles not strongly hooked at the end.....69.
Soldier without short projection on forehead; mandibles strongly hooked at the end; left mandible with a single tooth near the base. *Amitermes* (A.) *excellens* Silvestri p. 432.
69. Labrum of soldier nearly reaching tip of mandibles; left mandible without much dentation. *Cornitermes* (*Labiotermes*) *labralis* Holmgren p. 364.
Labrum of soldier not nearly reaching tip of mandibles; left mandible with a number of dentations. *Cornitermes* (C.) *pugnax*, sp. nov. p. 366.
70. Mandibles of soldiers degenerated into small functionless structures with or without points; long projection in front of the head.....71.
Mandibles of soldier not degenerate.....76.
71. Projection in front of head of soldier long and narrow, forked at tip.....72.
Projection in front of head of soldier not forked at tip.....25.
72. Head of soldier conspicuously constricted behind; anterior margin of pronotum projecting forward; head slightly darker than the rest of the body. *Rhinotermes* (R.) *subfusciceps*, sp. nov. p. 356.
Head of soldier not conspicuously constricted behind; anterior margin of pronotum not emarginate at tip73.
73. Antennae with 14 segments. *Rhinotermes* (R.) *longilabius*, sp. nov. p. 352.
Antennae with 15 or 16 segments.....74.
74. Head brown. *Rhinotermes* (R.) *tenebrosus*, sp. nov. p. 354.
Head yellow.....75.
75. Head with about 8 long bristles scattered about. *Rhinotermes* (R.) *marginalis* (Linné) p. 349.
Head with numerous bristles scattered about. *Rhinotermes* (R.) *hispidus*, sp. nov. p. 351.
76. Soldier with degenerate eyes visible as light spots behind the base of the antennae except in a few cases where the head is mostly black and foreshortened.....77.
Soldiers without degenerate eye; head nearly always light in color.....78.
77. Head of soldier proportionately long, brownish or yellowish; mandibles normal.....12.
Head of soldier proportionately short, partially or entirely black; mandibles very short.....16.
78. Front of head of soldier prolonged into a conspicuous nose reaching to or beyond the tip of the mandibles.....51.

- Front of head with or without conspicuous nose; if present, the nose is much shorter than the mandibles.....79.
79. Mandibles of soldier extremely asymmetrical55.
Mandibles of soldier more or less symmetrical80.
80. Mandibles of soldier very slender, without teeth except near the base; used for snapping.....58.
Mandibles of soldier used for biting, usually powerful and toothed.....81.
81. Pronotum of soldier with sharp lateral points; large species.....65.
Pronotum of soldier without sharp lateral points; medium sized or small species.....82.
82. Left mandible of soldier with 2 large conspicuous teeth.....5.
Left mandible of soldier without 2 large conspicuous teeth.....83.
83. Mandibles sickle-shaped.....84.
Mandible elbowed, the anterior portion bent outward, tips curved inward; a single tooth on the inner edge at the elbow.
Orthognathotermes macrocephalus (Holmgren) p. 161.
84. Left mandible without teeth or dentations except near the base.....85.
Left mandible with one or more conspicuous teeth or dentations.....87.
85. Forehead of soldier with 3-pointed projection. *Mirotermes* (*Spinitermes*) *trispinosus* (Bates) p. 444.
Forehead of soldier without 3-pointed projection.....86.
86. Head proportionately very long; mandibles short, .65-.75 mm. long; antennae with 11 segments. *Cylindrotermes nordenskiöldi* Holmgren p. 430.
Antennae with 14-16 segments; mandibles .90-1.25 mm. long.....10.
87. Both mandibles with minute dentations along entire inner edge.
Microcerotermes arboreus, sp. nov. p. 454.
Mandibles without minute dentations along the entire inner edge.....68.

LIST OF SPECIES

Family KALOTERMITIDAE

p. 316

Subfamily KALOTERMITINAE

Genus *Kalotermes*

Subgenus *Neotermes*

Kalotermes* (*Neotermes*) *clearei*, sp. nov.**Kalotermes* (*Neotermes*) *kartaboensis*, sp. nov.***Kalotermes* (*Neotermes*) *holmgreni* Banks

Subgenus *Rugitermes*

p. 320

Kalotermes* (*Rugitermes*) *bicolor*, sp. nov.**Kalotermes* (*Rugitermes*) *flavicinctus*, sp. nov.*****Kalotermes* (*Rugitermes*) *magninotus*, sp. nov.**

Subgenus *Cryptotermes*

p. 326

Kalotermes (*Cryptotermes*) *brevis* (Walker)

Kalotermes (Cryptoterme)s verruculosus, sp. nov.

Kalotermes (Cryptoterme)s ?) cubicoceps, sp. nov.

Subgenus *Glyptoterme*s

p. 331

Kalotermes (Glyptoterme)s pellucidus, sp. nov.

Kalotermes (Glyptoterme)s perparvus, sp. nov.

Kalotermes (Glyptoterme)s guianensis, sp. nov.

Kalotermes (Glyptoterme)s hospitalis, sp. nov.

Subgenus *Lobiterme*s

p. 337

Kalotermes (Lobiterme)s nigriceps, sp. nov.

Family RHINOTERMITIDAE

p. 340

Subfamily LEUCOTERMITINAE

Genus *Leucoterme*s

Leucoterme tenuis (Hagen)

Leucotermes crinitus, sp. nov.

Subfamily COPTOTERMITINAE

p. 344

Genus *Coptoterme*s

Coptoterme marabitanas (Hagen)

Subfamily RHINOTERMITINAE

p. 346

Genus *Rhinoterme*s

Subgenus *Rhinoterme*s

*Rhinoterme*s (*Rhinoterme*s) nastus (Perty)

*Rhinoterme*s (*Rhinoterme*s) marginalis (L.) (Hagen)

Rhinotermes (*Rhinoterme*s) hispidus, sp. nov.

Rhinotermes (*Rhinoterme*s) longilabius, sp. nov.

Rhinotermes (*Rhinoterme*s) tenebrosus, sp. nov.

Rhinotermes (*Rhinoterme*s) subfusciceps, sp. nov.

Family TERMITIDAE

p. 357

Genus *Synterme*s

Syntermes snyderi, sp. nov.

Syntermes territus, sp. nov.

Synterme parallelus Silvestri

Genus *Corniterme*s

p. 363

Subgenus *Labioterme*s

*Corniterme*s (*Labioterme*s) labralis Holmgren

Subgenus *Corniterme*s

p. 365

Cornitermes (*Corniterme*s) pugnax, sp. nov.

Genus *Armiterme*s

p. 367

Subgenus *Armiterme*s

Armitermes (*Armitermes*) *albidus* (Hagen)

Armitermes (**Armitermes**) **percutiens**, sp. nov.

Armitermes (**Armitermes**) **teevani**, sp. nov.

Armitermes (**Armitermes**) **grandidens**, sp. nov.

Armitermes (**Armitermes**) **minutus**, sp. nov.

Genus *Nasutitermes*

p. 375

Subgenus *Nasutitermes*

Nasutitermes (*Nasutitermes*) *guayanae* (Holmgren)

Nasutitermes (*Nasutitermes*) *costalis* (Holmgren)

Nasutitermes (*Nasutitermes*) *ephratae* (Holmgren)

Nasutitermes (*Nasutitermes*) *octopilis* Banks

Nasutitermes (*Nasutitermes*) *surinamensis* (Holmgren)

Nasutitermes (*Nasutitermes*) *acajutlae* (Holmgren)

Nasutitermes (*Nasutitermes*) *intermedius* Banks

Nasutitermes (**Nasutitermes**) **comstockae**, sp. nov.

Nasutitermes (**Nasutitermes**) **wheeleri**, sp. nov.

Nasutitermes (**Nasutitermes**) **banski**, nom. nov.

Nasutitermes (**Nasutitermes**) **gaigei**, sp. nov.

Nasutitermes (**Nasutitermes**) **brevipilus**, sp. nov.

Subgenus *Subulitermes*

p. 397

Nasutitermes (**Subulitermes**) **baileyi**, sp. nov.

Nasutitermes (*Subulitermes*) *parvellus* (Silvestri)

Nasutitermes (**Subulitermes**) **oculatissimus**, sp. nov.

Nasutitermes (**Subulitermes**) **raripilus**, sp. nov.

Nasutitermes (**Subulitermes**) **osborni**, sp. nov.

Nasutitermes (**Subulitermes**) **snyderi**, sp. nov.

Subgenus *Convexitermes*

p. 407

Nasutitermes (*Convexitermes*) *nigricornis* (Holmgren)

Nasutitermes (**Convexitermes**) **kartaboensis**, sp. nov.

Nasutitermes (**Convexitermes**) **mazaruniensis**, sp. nov.

Nasutitermes (**Convexitermes**) **manni**, sp. nov.

Subgenus *Velocitermes*

p. 414

Nasutitermes (**Velocitermes**) **beebei**, sp. nov.

Subgenus *Constrictotermes*

p. 416

Nasutitermes (*Constrictotermes*) *cavifrons* (Holmgren)

Subgenus *Angularitermes*, subg. nov.

p. 419

Nasutitermes (**Angularitermes**) **nasutissimus**, sp. nov.

Genus *Anoplotermes*

p. 420

Subgenus *Anoplotermes*

- Anoplotermes** (**Anoplotermes**) **meridianus**, nom. nov.
Anoplotermes (**Anoplotermes**) **silvestrii**, sp. nov.
Anoplotermes (**Anoplotermes**) **banksi**, sp. nov.
Anoplotermes (**Anoplotermes**) **brevipilus**, sp. nov.
Anoplotermes (**Anoplotermes**) **subterraneus**, sp. nov.
Anoplotermes (**Anoplotermes**) **nigripunctatus**, sp. nov.

Subgenus *Speculitermes* p. 427

- Anoplotermes** (**Speculitermes**) **arboreus**, sp. nov.

Genus *Cylindrotermes* p. 428

- Cylindrotermes nordenskiöldi* Holmgren

Genus *Amitermes* p. 430

Subgenus *Amitermes*

- Amitermes* (*Amitermes*) **excellens** Silvestri

Genus *Mirotermes* p. 432

Subgenus **Crepititermes** subg. nov.

- Mirotermes** (**Crepititermes**) **verruculosus**, sp. nov.

Subgenus *Mirotermes* p. 435

- Mirotermes* (*Mirotermes*) **nigritus** (Silvestri)
Mirotermes (*Mirotermes*) **hispaniolae** Banks
Mirotermes (**Mirotermes**) **acutinasus**, sp. nov.
Mirotermes (**Mirotermes**) **inquilinus**, sp. nov.

Subgenus *Cavitermes*, subg. nov. p. 442

- Mirotermes** (**Cavitermes**) **tuberosus**, sp. nov.

Subgenus *Spinitermes* p. 444

- Mirotermes* (*Spinitermes*) **trispinosus** (Bates)

Genus *Capritermes* p. 445

Subgenus *Neocapritermes*

- Capritermes* (*Neocapritermes*) **bodkini** Silvestri
Capritermes (**Neocapritermes**) **angusticeps**, sp. nov.
Capritermes (**Neocapritermes**) **planiceps**, sp. nov.

Genus *Orthognathotermes* p. 451

- Orthognathotermes macrocephalus* (Holmgren)

Genus *Microcerotermes* p. 453

- Microcerotermes arboreus**, sp. nov.

Family KALOTERMITIDAE Banks

Holmgren (1911) divided this family (= Protermitidae) into four subfamilies, namely Termopsinae, Hodotermitinae, Stolotermitinae, and Kalotermitinae. Of these only the Kalotermitinae are known from British Guiana.

Subfamily KALOTERMITINAE Holmgren

Holmgren (1911) placed two genera, *Porotermes* and *Kalotermes*, in this subfamily. Several authors have divided up the large genus *Kalotermes* into several genera but it seems less confusing to use Holmgren's classification for both genera and subgenera for the present, as no one has studied the group as a whole since 1911. Many of Holmgren's subgenera, however, seem distinct enough to warrant generic rank. *Kalotermes* is well represented in British Guiana.

Genus *Kalotermes* Hagen

Holmgren (1911) recognizes ten subgenera belonging to this genus. Of these five are known from British Guiana.

Subgenus *Neotermes* Holmgren

In the sense used by Holmgren this subgenus has a large distribution with fifty-two species. It is well represented in the Ethiopian, Oriental, Australian, Palaearctic and Neotropical regions. Three species were found in British Guiana, two of which seem to be new.

Kalotermes (Neotermes) clearei*, sp. nov. = *holmgreni

(Fig. 24)

Imago.—Head widely oval, rather short; brownish yellow; clothed with a number of rather short bristles; no median line or Y-suture visible.

Antennae with 18–19 segments, 2d segment equal to the 3d, 4th smaller than the 3d or about equal.

Eyes large, front margin straight near the base of the antennae. Ocelli medium sized, very close to the eyes.

Pronotum brownish yellow with numerous bristles; front margin concave, sides rounded, posterior margin rounded with middle very slightly emarginate.

Pulvillus present.

Wings transparent yellow brown; subcosta, radius, and media brown and distinct, cubitus not so distinct, with 12–16 branches; many small veins or thickenings between the radius and media in the outer half of the wing.

Abdominal tergites yellow, with numerous bristles.

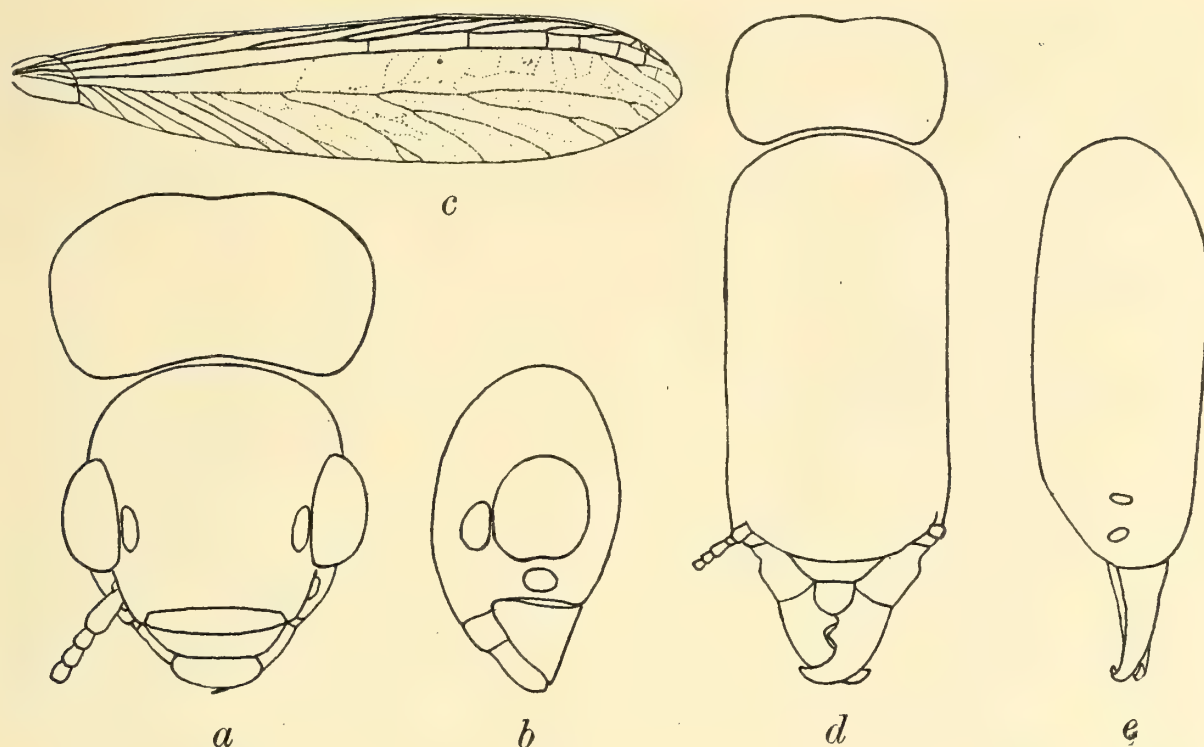


Fig. 24. *Kaloterмес (Neoterмес) clearei*, sp. nov. a, imago, dorsal view of head and pronotum; b, imago, lateral view of head; c, imago, wing; d, soldier, dorsal view of head and pronotum; e, soldier, lateral view of head.

Measurements.—

Length with wing.....	15.00–16.00 mm.
Length without wings.....	9.00–11.00 mm.
Length of head.....	1.82– 2.02 mm.
Width of head.....	1.71– 1.76 mm.
Length of antennae.....	2.73 mm.
Diameter of eye.....	.67 mm.
Length of pronotum.....	.80 mm.
Width of pronotum.....	1.90 mm.
Length of hind tibia.....	1.45 mm.
Length of anterior wing.....	11.50 mm.
Width of anterior wing.....	3.07 mm.

Comparison with other species.—*K. (Neoterмес) arthuri-muelleri* von Rosen, *K. fulvescens* Silv., *K. hirtellus* Silv. and *K. modestus* Silv. are all smaller. *K. castaneus* (Burm.) Banks has only 16 segments in the antennae. *K. chilensis* (Blanchard) Desn., and *K. holmgreni* Banks have rounder eyes.

Soldier.—Head brownish yellow, elongated; sides straight and parallel; front rather flat, sloping at an angle of about 35°; sparsely covered with short bristles.

Antennae with 15–17 segments, in all cases 3d segment conspicuously longer than 2d or 4th.

Eyes unpigmented, oval, about their length removed from the base of the antennae.

Mandibles black; left with 3 conspicuous teeth; right with 2 large teeth.

Pronotum yellow, front margin evenly concave; sides rounded not converging toward the rear; posterior margin nearly straight; pronotum about the same width as the head.

Spines on tibia and claws on tarsi with dark points. Pulvillus absent.

Abdomen pale yellow.

Measurements.—

Total length.....	11.82–12.94 mm.
Length of head.....	6.15 mm.
Width of head.....	2.71– 2.76 mm.
Length of antennae.....	2.41– 2.53 mm.
Length of pronotum.....	1.18– 1.23 mm.
Width of pronotum.....	2.53– 2.88 mm.
Length of hind tibia.....	1.71– 1.82 mm.
Length of left mandible.....	2.12– 2.23 mm.

Comparison with other species.—*K. castaneus* (Burm.) Banks has the 3d segment of the antennae not larger than the 2d. *K. wagneri* Desn. close, but the eye is pigmented and the measurements are larger. *K. fulvescens* Silv., *K. hirtellus* Silv., *K. latifrons* Silv., and *K. modestus* Silv. are all smaller.

Type locality.—Georgetown, British Guiana.

Range.—Known only from the type locality.

Holotype.—Winged Imago.

Morphotype.—Soldier.

Described from four winged imagos and two soldiers collected by L. D. Cleare, Jr. at Georgetown, B. G., in September, 1914, from a single colony in the Botanic Gardens. I take pleasure in naming the species in honor of the collector.

***Kaloterme* (*Neoterme*) *kartaboensis*, sp. nov.**

(Fig. 25, *a*, *b*, *c*)

Imago.—Head yellow brown with numerous bristles; oval.

Antennae with 18 segments; 2d, 3d, and 4th equal.

Eyes rather large, about $\frac{2}{3}$ their diameter from the lower margin of the head (.29 mm.). Front margin straight.

Ocelli medium sized, in contact with the eyes.

Pronotum yellow brown with numerous bristles; wider than head; sides rounded, posterior margin nearly straight.

Pulvillus present between claws.

Wings hyaline, veins near costal margin brown; subcosta, radius, and media distinct; cubitus indistinct except near the base. Radius with 6–8 branches; crossveins between the radius and media; cubitus 11–14 branched.

Abdomen yellow brown, tergites with numerous bristles.

Measurements.—

Length with wings.....	13.00–14.00 mm.
Length without wings.....	8.00– 8.50 mm.
Length of head.....	2.00– 2.12 mm.

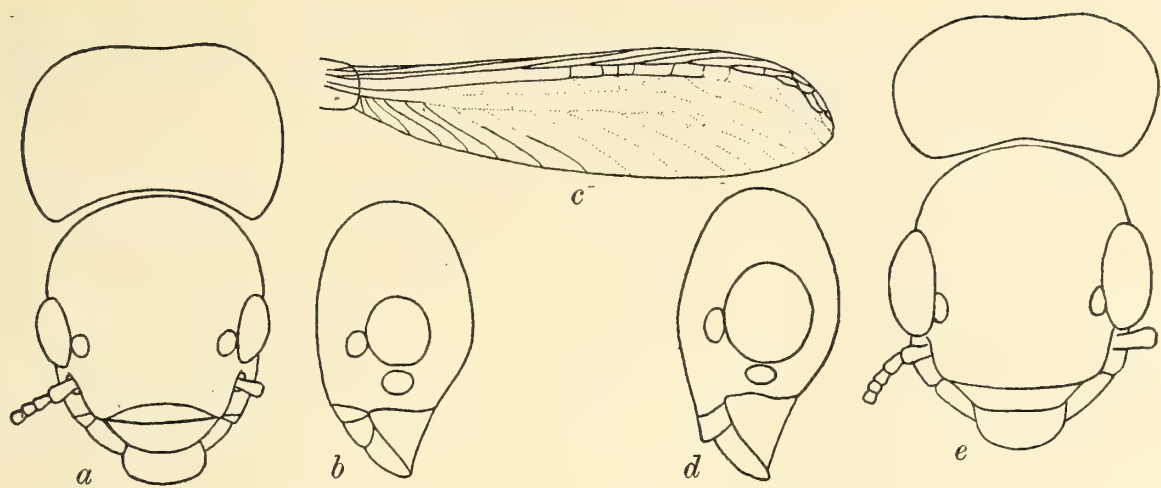


Fig. 25. *Kaloterмес (Neoterмес) kartaboensis*, sp. nov. a, imago, dorsal view of head and pronotum; b, imago, lateral view of head; c, imago, wing.
Kaloterмес (Neoterмес) holmgreni Banks. d, imago, lateral view of head; e, imago, dorsal view of head and pronotum.

Measurements.—

Width of head.....	1.76 mm.
Length of antennae.....	2.95 mm.
Diameter of eye.....	.43- .47 mm.
Length of pronotum.....	1.23 mm.
Width of pronotum.....	2.06 mm.
Length of anterior wing.....	10.29 mm.
Width of anterior wing.....	2.94 mm.

Comparison with other species.—*K. castaneus* (Burm.) Banks has only 16 segments in the antennae. *K. hirtellus* Silv. has 19 segments in the antennae and is smaller. The wings are wider in *K. chilensis* (Blanchard) Desn. The eye in *K. holmgreni* Banks is only ½ its diameter from the lower margin of the head and is round in front. *K. arthuri-muelleri* von Rosen, *K. fulvescens* Silv. and *K. modestus* Silv. are all smaller.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Winged imago.

Described from five imagos collected by the author at Kartabo.

Kaloterмес (Neoterмес) holmgreni Banks

Neoterмес holmgreni Banks (1918), p. 659, pl. LI, fig. 9 (imago).

(Fig. 25, d, e)

Imago.—Head reddish yellow, short, widely oval with a number of rather long bristles.

Antennae with 17 segments, 2d segment larger than the 3d, 3d equal to the 4th.

Eyes large, a littles less than ½ their width (.19 mm.) from the lower margin; front margin rounded.

Ocelli very close to the eyes, oval.

Pronotum the same color as the head and about the same width as the head. Pulvillus conspicuous.

Wings brownish yellow, transparent; costal veins, radius, subcosta and media distinct; cubitus not so distinct and with 11-14 branches. Venation very similar to *K. kartaboensis*, n. sp.

Abdominal tergites yellow.

Measurements.—

Length with wings.....	14.00 mm.
Length without wings.....	8.00 mm.
Length of head.....	1.83 mm.
Width of head.....	1.57 mm.
Length of antennae.....	2.25 mm.
Diameter of eye.....	.64 mm.
Length of pronotum.....	.80 mm.
Width of pronotum.....	1.57 mm.
Length of hind tibia.....	1.35 mm.
Length of anterior wing.....	10.25 mm.
Width of anterior wing.....	2.95 mm.

Comparison with other species.—*K. castaneus* (Burm.) Banks larger and antennae with 16 segments. *K. chilensis* (Blanchard) Desn. larger. *K. fulvescens* Silv. close but smaller. *K. hirtellus* Silv. close but wings differ in shape and the measurements are slightly smaller. *K. modestus* Silv. has a wider pronotum.

Type locality.—Panama, Taboga Island (Banks, 1918).

New locality.—Georgetown, British Guiana.

Range.—Panama, British Guiana.

This description is taken from a single winged imago collected by the author in Georgetown, B. G., May 26, 1920. It seems to answer the description given by Banks (1918).

Subgenus *Rugitermes* Holmgren

This subgenus is small, formerly known only from southern South America and including three species. Three species were found at Kartabo, all of which seem to be new.

***Kalotermos (Rugitermes) bicolor*, sp. nov.**

(Fig. 26)

Imago (Queen).—Head black or very dark brown.

Antennae yellow (broken beyond 9th segment), 2d, 3d, and 4th segments about equal.

Eyes small, .26 mm. removed from the lower margin of the head.

Ocelli rather small, .08 mm. removed from the eyes.

Labrum yellowish. Clypeus pale. Sides of thorax dark.

Pronotum yellow, contrasting strongly with the head and wing scales; front margin concave, sides rounded, hind margin somewhat concave.

Coxae, femora and upper part of tibiae dark, lower part of tibiae yellowish.

Wing scales very dark brown, contrasting strongly with the pronotum.

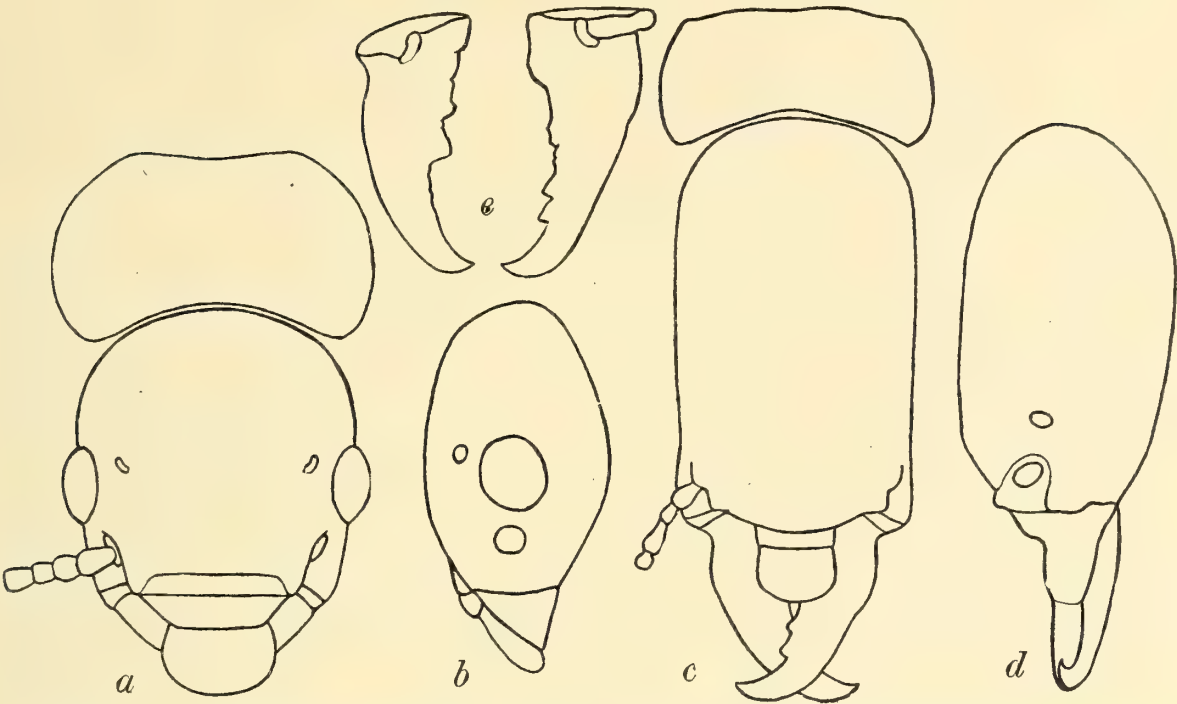


Fig. 26. *Kaloterms (Rugitermes) bicolor*, sp. nov. a, imago, dorsal view of head and pronotum; b, imago, lateral view of head; c, soldier, dorsal view of head and pronotum; d, soldier, lateral view of head; e, soldier, mandibles.

Abdominal tergites and sternites yellow.

Measurements.—

Length of head.....	1.86 mm.
Width of head.....	1.51 mm.
Diameter of eye.....	.35 mm.
Length of pronotum.....	.77 mm.
Width of pronotum.....	1.65 mm.
Length of hind tibia.....	1.28 mm.
Length of queen.....	8.27 mm.

Comparison with other species.—Differs from *K. magninotus*, n. sp., and *K. flavicinctus*, n. sp. in that the upper part of the tibia is the same color as the femur while the lower part near the tarsus is conspicuously lighter. *K. bicolor* is also larger than these two species. *K. rugosus* Hagen Silv. is smaller. *K. occidentalis* Silv. differs in the following measurements; width of head 1.35 mm., length of pronotum 1.00 mm., width of pronotum 1.70 mm. *K. nodulosus* Hagen differs in that the pronotum is narrower than the head.

Soldier.—Head yellowish brown, darker in front than behind; rectangular, sides straight and parallel. Front covered with numerous bristles which grow scarce toward the rear. Forehead rather flat, sloping gradually.

Antennae with 14–17 segments; in all cases the 3d segment is conspicuously larger than the 2d, the 2d somewhat longer than the 4th.

Eyes unpigmented. A small white spot above the eye may possibly be a rudimentary ocellus.

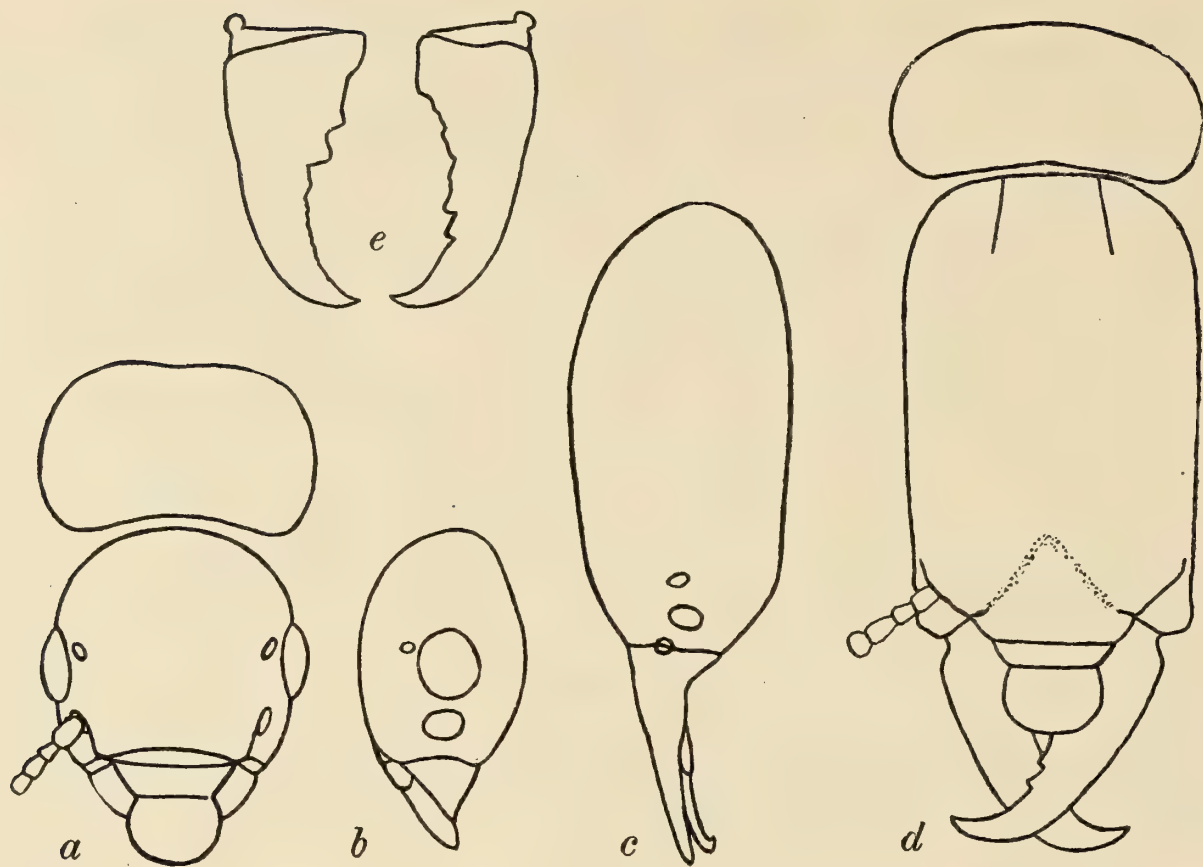


Fig. 27. *Kaloterme (Rugiterme) flavicinctus*, sp. nov. a, imago, dorsal view of head and pronotum; b, imago, lateral view of head; c, soldier, lateral view of head; d, soldier, dorsal view of head and pronotum; e, soldier, mandibles.

Mandibles black, the left with several rather small teeth, the right with 2 conspicuous teeth.

Pronotum yellow, same color as back of head; front margin concave, sides rounded, posterior margin bow-shaped, forming an angle with the sides.

Pulvillus present. Abdomen yellow.

Measurements.—

Total length	8.86–10.99 mm.
Length of head	3.78– 4.25 mm.
Width of head	1.80– 2.07 mm.
Length of pronotum	.67– .93 mm.
Width of pronotum	1.67– 2.15 mm.
Length of hind tibia	1.28– 1.35 mm.

Comparison with other species.—*K. magninotus* and *K. flavicinctus* are both conspicuously smaller. In *K. occidentalis* Silv. the width of the pronotum is 2.40 mm. and the length of the pronotum 1.20 mm. In *K. rugosus* Hag. Silv. the width of the head is 1.70 mm. and the length of the pronotum 1.00 mm. The antennae of *K. rugosus* has 13 segments.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Queen.

Morphotype.—Soldier.

The description was taken from a single queen and numerous soldiers collected by the author from a single colony at Kartabo.

Kalotermes (Rugitermes) flavicinctus, sp. nov.

(Fig. 27)

Imago (Queen).—Head medium dark brown, contrasting strongly with the pronotum; widely oval.

Antennae yellow, the 2d segment slightly longer than the 3d, the 3d slightly longer than the 4th.

Eyes rather small, .126 mm. removed from the lower margin of the head; somewhat oval in shape.

Ocelli medium sized, oval, .032 mm. removed from the eyes.

Labrum yellow, clypeus white. Sides of thorax yellow, about the same color as the abdomen.

Pronotum yellow, contrasting strongly with the dark head and wing scales.

Legs yellow throughout. Pulvillus conspicuous.

Wing scales nearly as dark as the head, contrasting strongly with the yellow pronotum.

Abdominal tergites yellow; sternites brownish, much darker than the tergites.

Measurements.—

Length of head	1.38 mm.
Width of head	1.19 mm.
Diameter of eye . . . . .	.32 mm.
Length of pronotum . . . . .	.61 mm.
Width of pronotum	1.16 mm.
Length of hind tibia . . . . .	.93 mm.
Length of queen	5.67 mm.

Comparison with other species.—This is the smallest species of *Rugitermes* yet known and differs from *K. bicolor*, *K. magninotus*, *K. nodulosus*, and *K. rugosus* in having the sides of the thorax the same color as the abdomen and the legs uniformly yellow throughout.

Soldier.—Head yellow brown in back, darker in front; clothed with numerous bristles which grow scarcer toward the rear; head long, sides straight and parallel, hind margin rounded, front sloping slightly with a very shallow groove in the middle.

Antennae with 15–16 segments, the 3d segment longer than the 2d and enlarged at the tip, the 2d segment longer than the 4th. The first 3 segments are darker than the rest, which are yellow.

Mandibles black, the left with several rather small teeth and the right with 2 conspicuous teeth.

Pronotum yellow with numerous bristles; front margin concave, sides rounded, hind margin with 2 very wide angles. Pronotum about the same width as the head or very slightly wider.

Abdomen yellow with numerous bristles on the tergites and sternites.

Measurements.—

Total length.....	6.03 mm.
Length of head.....	2.89–3.28 mm.
Width of head.....	1.19–1.35 mm.
Length of pronotum.....	.58–.67 mm.
Width of pronotum.....	1.19–1.35 mm.
Length of hind tibia.....	.83–.99 mm.

Comparison with other species.—Differs from *K. occidentalis* Silv. in size and the proportion of the width of the pronotum to the head. Differs from *K. magninotus* in the pronotum being the same width as the head while in *K. magninotus* the pronotum is wider than the head and is also proportionately longer. The femora of *K. flavicinctus* are proportionately more slender than in *K. magninotus*.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Queen.

Morphotype.—Soldier.

The description was taken from one queen and three soldiers collected by the author from a single colony at Kartabo.

***Kaloterme* (*Rugiterme*) *magninotus*, sp. nov.**

(Fig. 28)

Imago (King).—Head black. Antennae yellowish, the 2d segment equals the 3d, the 3d is a little longer than the 4th.

Eyes rather small, .26 mm. removed from the lower margin.

Ocelli small, .064 mm. removed from the eyes.

Labrum yellow. Clypeus white. Sides of thorax brown.

Pronotum yellow, anterior margin concave, sides rounded, converging somewhat near the rear; posterior margin somewhat emarginate.

Legs yellowish brown throughout; pulvillus conspicuous.

Wing scales dark brown, contrasting strongly with the yellow pronotum and abdomen.

Abdominal tergites yellow; sternites brownish yellow, a little darker than the tergites.

Measurements.—

Length of head.....	1.48 mm.
Width of head.....	1.25 mm.
Diameter of eye.....	.32 mm.
Length of pronotum.....	.71 mm.
Width of pronotum.....	1.35 mm.
Length of hind tibia.....	1.00 mm.

Comparison with other species.—Differs from *K. flavicinctus* in being a

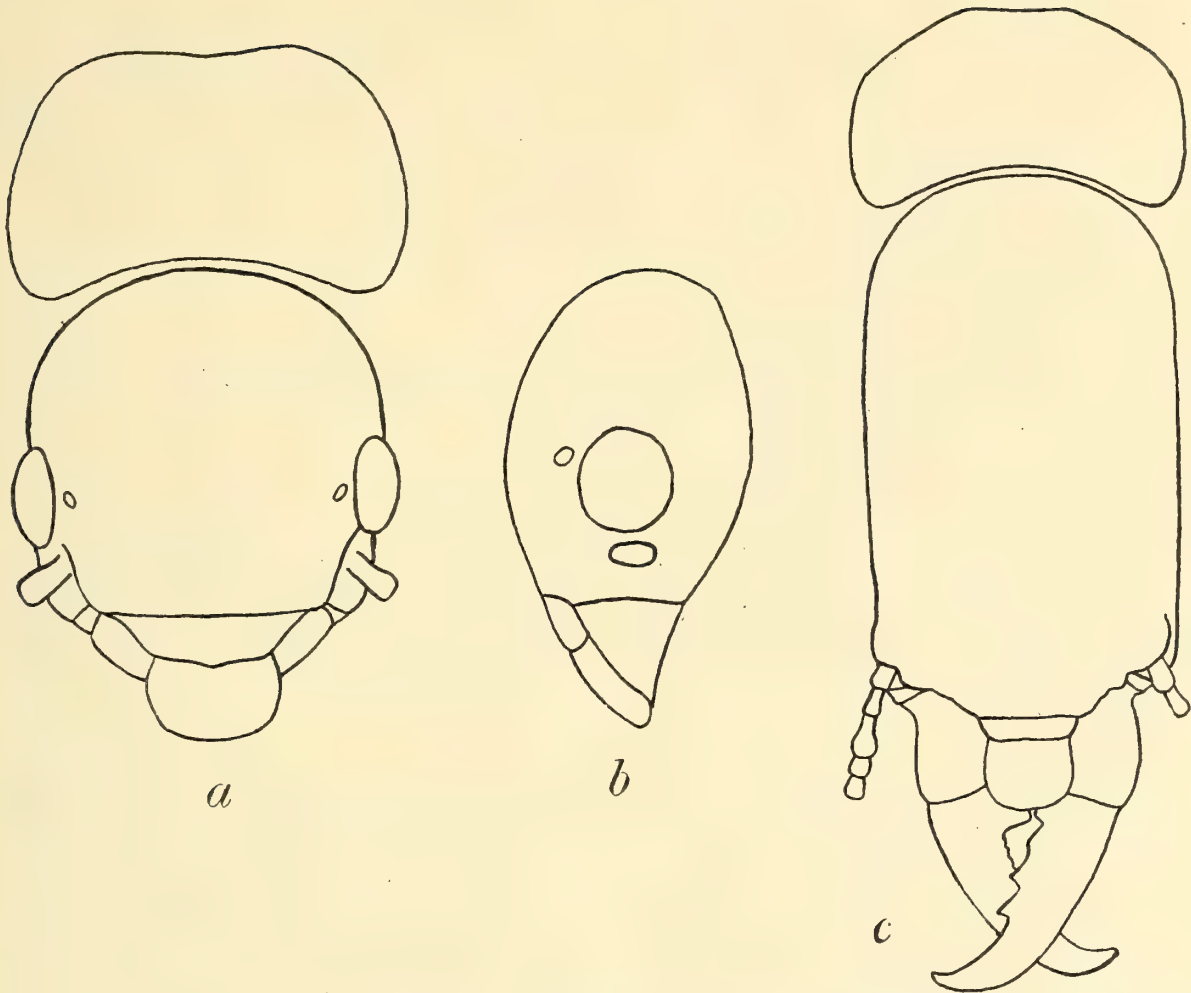


Fig. 28. *Kaloterмес (Rugiterмес) magninotus*, sp. nov. *a*, imago, dorsal view of head and pronotum; *b*, imago, lateral view of head; *c*, soldier, dorsal view of head and pronotum.

little larger, the head and wing scales are a little darker, the sides of the thorax are conspicuously darker, and the legs are darker. Differs from *K. bicolor* in having the legs uniform in color throughout. *K. magninotus* is close to the description of *K. rugosus* and may possibly be that species. However, as the soldiers which Silvestri (1903) assigns to this species differ so much in size from those of *K. magninotus*, it seems best to keep the species separate for the present. *K. occidentalis* is larger. The descriptions of *K. nodulosus* are not detailed enough to be sure of the species, but as Hagen (1858) describes the feet as yellowish except near the base and states that the pronotum is narrower than the head, I do not believe that *K. magninotus* can be assigned to *K. nodulosus*.

Soldier.—Antennae with 13–14 segments.

Differs from *K. flavicinctus* in size, the femora are proportionately much larger and the pronotum is proportionately wider and longer in relation to the head. *K. rugosus* Hag. Silv. and *K. occidentalis* Silv. are larger.

Measurements.—

Length of head	3.21–3.53 mm.
Width of head	1.38–1.48 mm.
Length of pronotum	.71–.83 mm.

Measurements.—

Width of pronotum	1.51–1.67 mm.
Length of hind tibia	1.03–1.12 mm.
Length of left mandible	1.42 mm.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—King.

Morphotype.—Soldier.

Described from one king and numerous soldiers collected by the author from three different colonies at Kartabo.

Subgenus *Cryptotermes* Banks

This subgenus now contains twenty-seven described species and is known from the Oriental, Australian, Ethiopian, Nearctic and Neotropical regions. Two of the three species found in British Guiana are new, which makes seven Neotropical species of the subgenus.

Kalotermes (Cryptotermes) brevis (Walker)

The following synonymy is taken from the literature and very probably contains more than one species, as the imagos of this subgenus are rather difficult to separate:

- Termes brevis* Walker (1853), p. 524 (imago).
- Calotermes brevis* Hagen (1858), p. 68 (imago), pl. 2, fig. 6; pl. 3, fig. 5 (imago).
- Termes indecisus* Walker (1853), p. 524 (imago).
- Termes flavicollis* Walker (1853), p. 502 (No. 1, imago).
- Termes lucifugus* Walker (1853), p. 505 (No. 2, imago).
- Calotermes brevis* Hagen (1858a), p. 10 (imago).
- Calotermes brevis* Hagen (1860a), p. 101 (biology, etc.).
- Calotermes (Cryptotermes) brevis* Holmgren (1911), p. 55.
- Calotermes brevis* Desneux (1915), p. 6.
- Cryptotermes brevis* Banks (1919), p. 476 (locality).
- Cryptotermes brevis* Banks (and Snyder) (1920), p. 36, text-fig. 23(3) (soldier).

(Fig. 29)

Imago.—Head medium reddish brown, lighter on the sides and in front; oval; clothed with short hairs.

Antennae with 16–18 segments; the 2d segment about equal to the 3d or 4th.

Eyes of medium size, shape varying somewhat from subtriangular to circular in individuals from the same colony; about $\frac{3}{4}$ their diameter from the lower margin of the head.

Ocelli of medium size; in contact with the eyes.

Pronotum same color as the head; narrower than the head, sides depressed and rounded; posterior margin slightly emarginate; covered with short hairs.

Wings hyaline; costal margin and radius brown, radius with numerous accessory veins; subcosta and radius distinct, media and cubitus indistinct, the media running into the radius about $\frac{1}{4}$ the length of the wing from the tip; cubitus with 11–17 branches.

Abdomen same color as the head; clothed with short hairs.

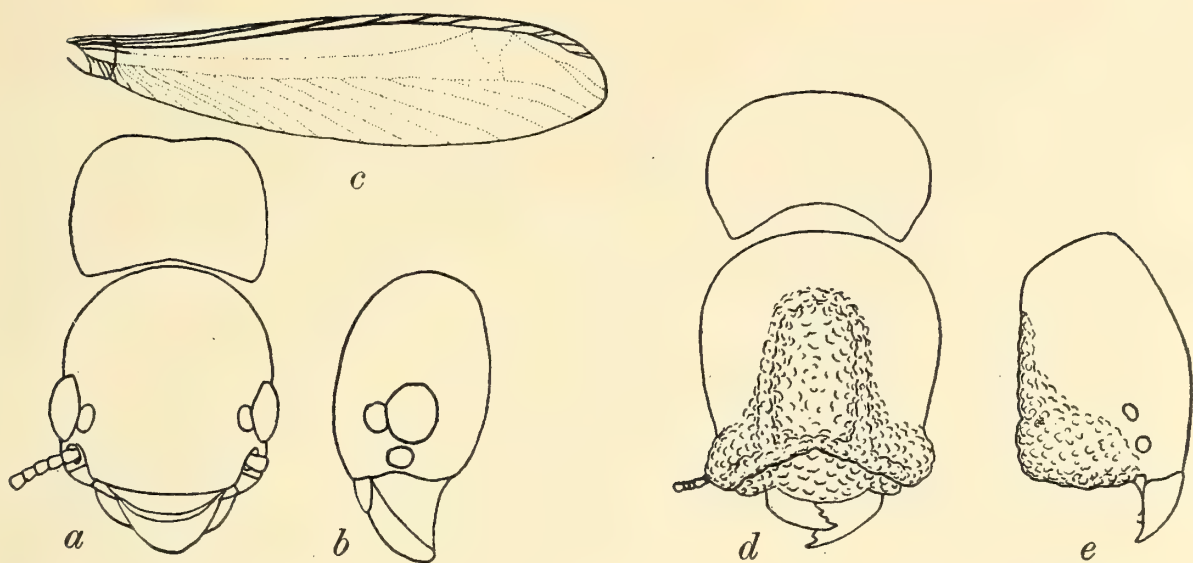


Fig. 29. *Kaloterms (Cryptoterms) brevis* (Walker). *a*, imago, dorsal view of head and pronotum; *b*, imago, lateral view of head; *c*, imago, wing; *d*, soldier, dorsal view of head and pronotum; *e*, soldier, lateral view of head.

Measurements.—

Length with wings	10.59–11.76 mm.
Length without wings	5.00– 5.88 mm.
Length of head	1.23– 1.35 mm.
Width of head	1.05– 1.12 mm.
Length of antennae	1.76– 1.93 mm.
Diameter of eye . . . . .	.11– .13 mm.
Length of pronotum . . . . .	.59– .65 mm.
Width of pronotum . . . . .	.94– 1.00 mm.
Length of hind tibia . . . . .	.90 mm.
Length of anterior wing	8.65– 8.74 mm.
Width of anterior wing	2.23– 2.35 mm.

Comparison with other species.—*K. brevicollis* Banks much smaller. *K. dudleyi* Banks seems to be a little smaller, otherwise the description is very close. *K. cavifrons* Banks is smaller and the antennae have 15 segments. *K. infumatus* Banks differs in that the cubitus bends upward and meets the radius near the tip of the wing. Agrees with the description of *K. pseudobrevis* Fuller and is probably the same species.

Remarks.—Walker gives the length as 18 mm. (8 lines). Hagen, however, gives the length with wings as 9 mm. and Hagen supposedly went over Walker's collection.

Soldier.—Head black merging to dark brown on the sides and back; clothed with numerous short hairs; short, top concave and front concave leaving sharp ridges between the front and sides and the front and top, ridges between the top and sides not as sharp as the others but distinct; front, top, and anterior portion of the sides above the base of the antennae roughened.

Antennae yellow; with 13 segments, the 3d segment very short.

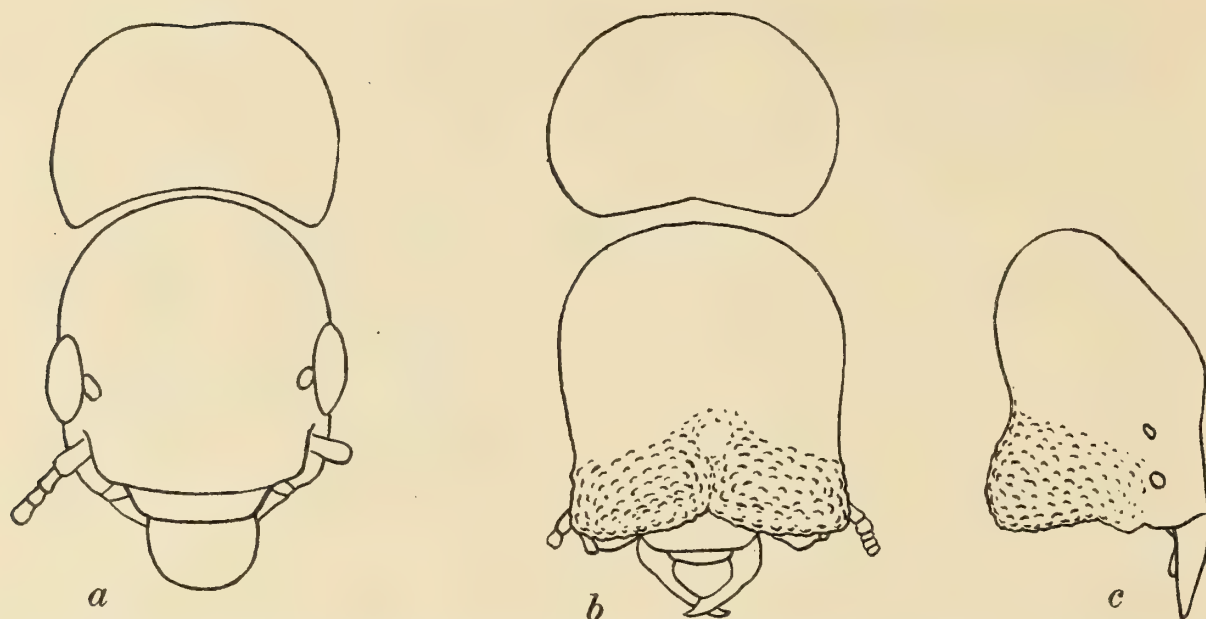


Fig. 30. *Kaloterme (Cryptoterme) verruculosus*, sp. nov. .a, imago, dorsal view of head and pronotum; b, soldier, dorsal view of head and pronotum; c, soldier, lateral view of head.

Eyes distinguishable behind the base of the antennae, lighter than the head and darker than the antennae.

Mandibles black.

Pronotum the same color as the head except a few spots of opaque yellow; anterior margin strongly concave, ending in 2 sharp points where it meets the sides; sides and posterior margin rounded. Legs pale. Abdomen pale with numerous short hairs.

Measurements.—

Total length	7.76 mm.
Length of head	1.88 mm.
Width of head	1.35 mm.
Length of antennae	1.18 mm.
Length of pronotum	.71 mm.
Width of pronotum	1.29 mm.
Length of hind tibia	.94 mm.

Comparison with other species.—*K. brevicollis* Banks smaller, front smooth. *K. dudleyi* Banks not roughened above, pronotum without anterior points. *K. longicollis* Banks much smaller, shape of head and pronotum entirely different. *K. cavifrons* Banks with smooth top.

Agrees with the description of *K. pseudobrevis* Fuller and is probably the same species.

Type locality.—Jamaica.

New localities.—British Guiana: Georgetown, Penal Settlement, Kartabo.

Range (not well established).—Mexico, Central America, West Indies, Colombia, British Guiana, Brazil.

The description is based upon numerous winged imagos and a soldier from

a single colony collected by the author in Georgetown. Several other winged imagos from the Penal Settlement and Kartabo agree with the Georgetown specimens. I am not certain that this is *Kaloterme brevis* Walker, because no adequate description of either the imago or soldier has ever been published. The British Guiana specimens, however, agree with specimens from the West Indies, the soldier of which has been figured by Banks and Snyder (1920), and which they refer to *K. brevis*. I am also of the opinion that this is the same species described by Fuller, 1921, as *Cryptoterme pseudobrevis* and if the name *brevis* is discarded, Fuller's name should be applied to this species.

Kaloterme (Cryptoterme) verruculosus, sp. nov.

(Fig. 30)

Imago.—Head reddish yellow. Antennae with the 3d segment shorter than the 2d, the 2d equal to the 4th. Eyes .192 mm. from the lower margin of the head.

There seems to be little difference between this species and *K. brevis* except in size.

Measurements.—

(The measurements of the winged specimens were taken from individuals not associated with the queen and soldier types.)

Length with wings.....	9.45 mm.
Length without wings.....	4.73 mm.
Length of head.....	1.12 mm.
Width of head.....	.96 mm.
Length of pronotum.....	.51 mm.
Width of pronotum.....	.87 mm.
Length of hind tibia.....	.71 mm.
Length of anterior wing.....	6.85 mm.
Width of anterior wing.....	1.89 mm.
Length of queen.....	4.82 mm.

Comparison with other species.—No distinct difference exists between this species and *K. brevis* except in size. *K. infumatus* Banks has different wing venation. *K. brevicollis* Banks is smaller. *K. dudleyi* Banks is larger.

Soldier.—Head black in front, reddish yellow brown in back; a few bristles at the back of the head; shape similar to *K. brevis* but differs in the top of the head not being indented so strongly and not as tuberculate. Forehead tuberculate; profile not as straight as *K. brevis*.

Antennae pale, 11–12 segmented; 3d and 4th segments equal and very short, 2d as long as the 2d and 4th together.

Eyes visible in back of the antennae bases.

Mandibles black and short.

Pronotum same color as back of head; front margin emarginate with a distinct angle in the middle; anterior angles rounded, not pointed as in *K. brevis*.

Abdominal tergites yellow.

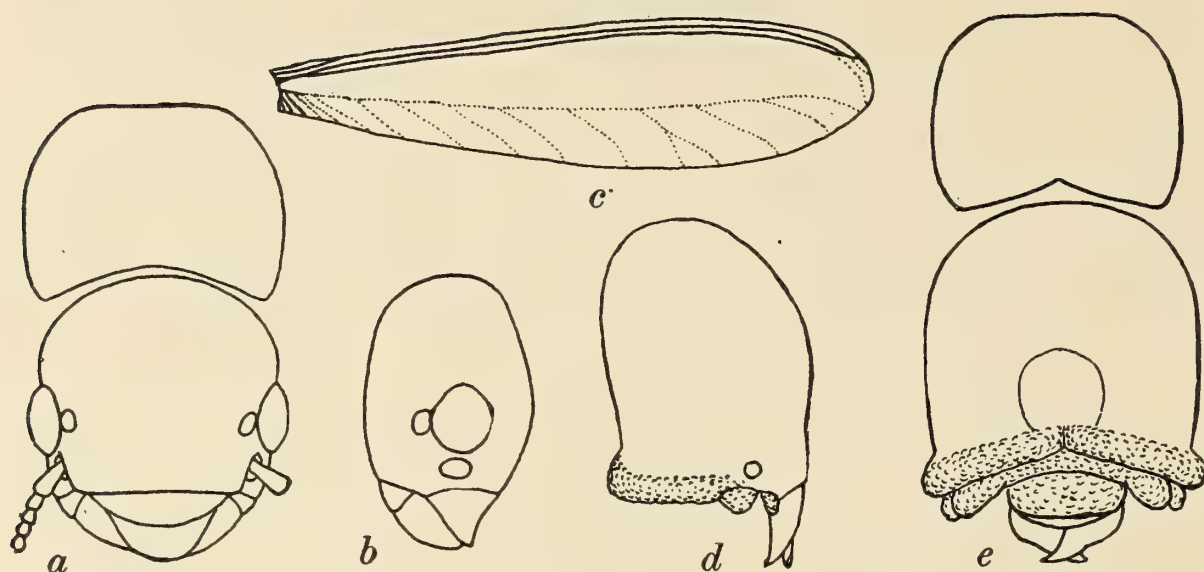


Fig. 31. *Kaloterme (Glyptoterme) pellucidus*, sp. nov. a, imago, dorsal view of head and pronotum; b, imago, lateral view of head; c, imago, wing.

Kaloterme (Cryptoterme ?) cubicoceps, sp. nov. d, soldier, lateral view of head; e, soldier, dorsal view of head and pronotum.

Measurements.—

Total length	4.50 mm.
Length of head	1.28–1.38 mm.
Width of head	1.03 mm.
Length of antennae . . . . .	.81 mm.
Length of pronotum (middle) . . . . .	.58–.61 mm.
Width of pronotum . . . . .	.96 mm.
Length of hind tibia . . . . .	.61 mm.

Comparison with other species.—The front angles of the pronotum are more round than in *K. brevis* and the top of the head is not so strongly tuberculate. Heads of *K. dudleyi*, *K. brevicollis*, and *K. longicollis* are not so tuberculate on top.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Soldier.

Morphotype.—Queen.

Described from one queen and six soldiers from two different colonies. A single winged imago taken separately seems to agree with the queen, so the measurements are added.

***Kaloterme (Cryptoterme ?) cubicoceps*, sp. nov.**

(Fig. 31, d, e)

Soldier.—Head yellow brown, front black; only 2 or 3 bristles on head; shape short and thick, front concave with a thick ridge between the front and top and the front and sides. Front with 2 pairs of short rounded projections, one on each side of the base of the mandible and one on each side of the clypeus. Top of head concave near the front, rest smooth and convex; ridge between

the top and front deeply indented in the middle; ridges and front tuberculate. Antennae yellow; with 12 segments; 3d segment shorter than the 4th, 4th shorter than the 2d.

Eyes practically invisible, same color as the head.
Mandibles short and black.

Pronotum yellow brown with numerous bristles; anterior margin widely emarginate, sides rounded, posterior margin nearly straight; angles between anterior margin and sides rounded.

Abdominal tergites pale with numerous bristles. Styli present, not rudimentary.

Measurements.—

Total length	5.88 mm.
Length of head	2.65 mm.
Width of head	2.12 mm.
Length of antennae	1.53 mm.
Length of pronotum	1.23 mm.
Width of pronotum	1.88 mm.
Length of hind tibia	1.25 mm.

Type locality.—Kartabo, British Guiana.
Range.—Known only from the type locality.
Holotype.—Soldier.

Described from a single soldier collected by the author in a dead liana stem at Kartabo. When collected I thought that it belonged to a colony of the species I am describing as *Kaloterme* (*Glyptoterme*) *pellucidus*, n. sp. although I did not see it with any termites. As the imago, however, has the characteristics of the subgenus *Glyptoterme* and the soldier does not, I think that they must be separate species.

This soldier differs from Holmgren’s description of the subgenus in that the styli are distinct and are not rudimentary.

Subgenus *Glyptoterme* (Froggatt)

The characteristics of a number of South American species agree with this subgenus and I am therefore referring them to *Glyptoterme*. Species belonging to *Glyptoterme* have been reported from the Australian, Oriental and Ethiopian regions. I also believe that *K. taurocephalus* Silv., *K. temnocephalus* Silv., and *K. triceromegas* Silv. belong to this subgenus, all three reported from South America. Counting the new species described in this report, there are now twenty-seven species known belonging to this subgenus. They are distributed as follows:—Australian Region seven, Oriental Region eight, Neotropical Region eight, Madagascar and adjoining islands two, Africa one, unknown habitat one.

Kaloterme (*Glyptoterme*) *pellucidus*, sp. nov.

(Fig. 31, a, b, c)

Imago.—Head brownish yellow; widely oval; clothed with a few hairs.

Antennae with 13 segments, the 2d, 3d and 4th equal.

Eyes of medium size, nearly $\frac{3}{4}$ their diameter from the lower margin of the head.

Ocelli small, in contact with the eyes.

Pronotum brownish yellow; clothed with a few hairs; slightly narrower than the head, sides depressed and rounded, posterior margin nearly straight.

Femora of legs somewhat enlarged, pulvillus present.

Wings hyaline; subcosta joining costal margin about $\frac{1}{11}$ the length of the wing from the base; radius parallel to the costal margin, with no branches except near the tip; media usually coalescing with the radius in at least one forewing, usually for a distance of about $\frac{1}{5}$ the length of the wing from the base and then running parallel to the radius for the rest of the length of the wing. The subcosta, radius, and media distinct; the cubitus indistinct with 13-16 branches.

Abdominal tergites brownish yellow, with a few hairs.

Measurements.—

Length with wings.....	7.00-8.00 mm.
Length without wings.....	4.41-4.70 mm.
Length of head.....	1.06-1.12 mm.
Width of head.....	.88- .94 mm.
Length of antennae.....	1.00-1.05 mm.
Diameter of eye.....	.27- .29 mm.
Length of pronotum.....	.52- .53 mm.
Width of pronotum.....	.82- .85 mm.
Length of anterior wing.....	5.76-5.88 mm.
Width of anterior wing.....	1.59-1.63 mm.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality

Holotype.—Winged imago.

The description is based upon eight winged imagos and two dealated specimens which were found at different times, the winged forms in every case flying to lights singly. The dealated specimens, together with several nymphs, were found in a dead liana stem from which the single specimen of *K. cubicocephus* was taken. They were not seen together, and as the soldier shows a close relationship to *Cryptotermes* and the imago compares well with the winged imagos which have the characteristics of *Glyptotermes*, I have described them separately. However, it is possible that they are the same species.

***Kalotermes (Glyptotermes) perparvus*, sp. nov.**

(Fig. 32)

Imago.—Head dark brown with a few bristles; suboval, relatively thick; Y-suture present; two round muscle insertions half-way between the ocelli and clypeus.

Antennae a little lighter than the head, with 11-12 segments, the 2d, 3d, and 4th equal.

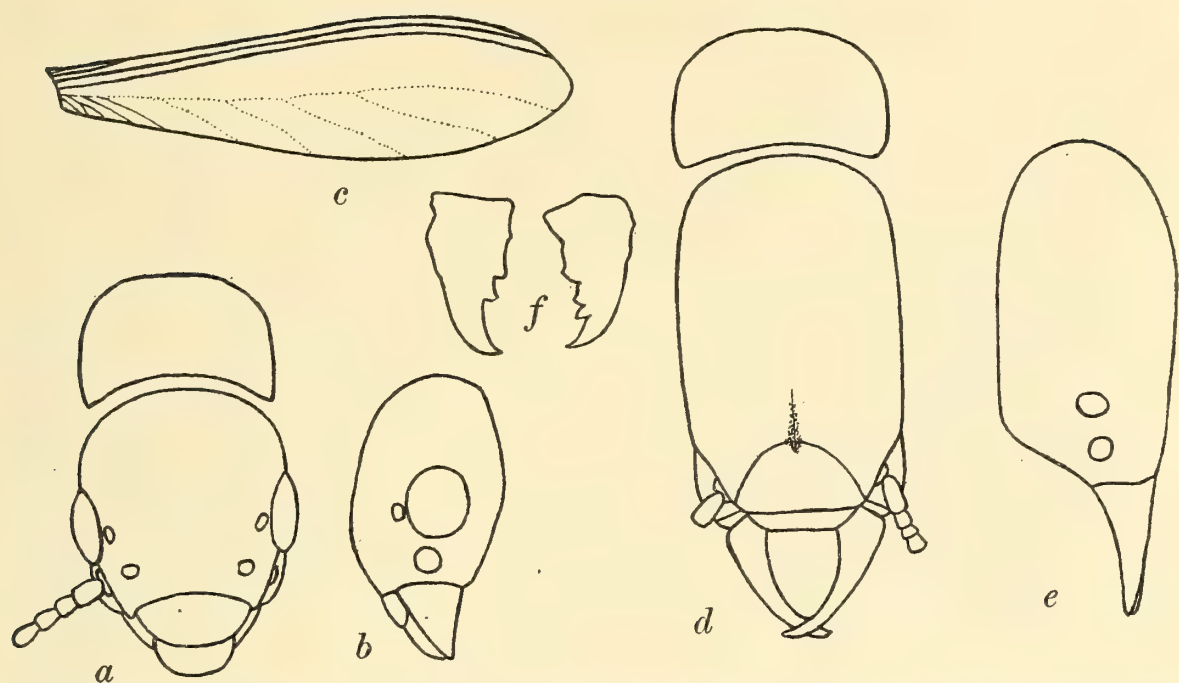


Fig. 32. *Kaloterмес (Glyptotermes) perparvus*, sp. nov. a, imago, dorsal view of head and pronotum; b, imago, lateral view of head; c, imago, wing; d, soldier, dorsal view of head and pronotum; e, soldier, lateral view of head; f, soldier, mandibles.

Eyes medium sized, about $\frac{1}{2}$ their diameter from the lower margin.
Ocelli medium sized, very close to the eyes.
Pronotum dark brown, slightly lighter than the head; clothed with a few bristles; anterior margin rounded, sides somewhat depressed; pronotum a little narrower than the head.
Wings hyaline, the costal border, radius and media dark; membrane stippled, giving a rather dark appearance to the wings; 2 short veins running from the wing suture into the costal border, one distinct, the other barely visible; radius and media parallel, unbranched; outer portion of the cubitus indistinct.
Abdominal tergites dark brown, same color as pronotum; clothed with a few bristles.

Measurements.—

Length with wings.....	5.80–6.47 mm.
Length without wings.....	3.40–4.00 mm.
Length of head.....	.86–.94 mm.
Width of head.....	.76–.77 mm.
Length of pronotum.....	.47–.51 mm.
Width of pronotum.....	.61–.66 mm.
Length of anterior wing.....	4.40–4.59 mm.
Width of anterior wing.....	1.18–1.20 mm.
Length of queen.....	5.14 mm.
Length of king.....	4.02 mm.

Soldier.—Head dark reddish brown in front, posterior part lighter; clothed with a few short bristles; long, sides straight and parallel, posterior margin rounded; forehead steep but not vertical, front conspicuously lobed.

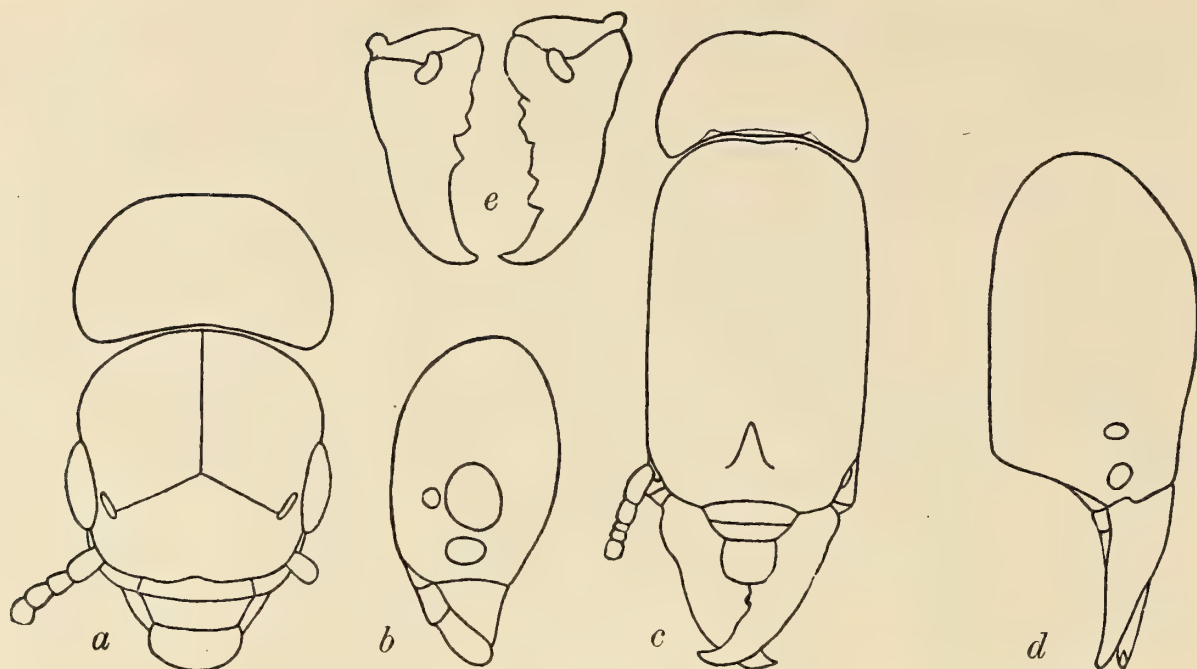


Fig. 33. *Kalotermes (Glyptotermes) guianensis*, sp. nov. a, imago, dorsal view of head and pronotum; b, imago, lateral view of head; c, soldier, dorsal view of head and pronotum; d, soldier, lateral view of head; e, soldier, mandibles.

Antennae pale yellow, with 10–11 segments.

Eyes unpigmented. Mandibles black, strongly toothed, the right with 2 distinct teeth and the left with 3.

Pronotum same color as back of head, with a number of bristles on the margins but only a few in the middle; anterior margin very slightly emarginate; sides somewhat depressed.

Legs pale yellow, femora stout.

Abdominal tergites with a few short bristles.

Measurements.—

Total length	4.50–4.60 mm.
Length of head	1.59–1.73 mm.
Width of head	.76–.84 mm.
Length of antennae	.75–.86 mm.
Length of pronotum	.40–.42 mm.
Width of pronotum	.76–.77 mm.
Length of left mandible	.57 mm.

Comparison with other species.—The soldier is smaller than *K. temnocephalus* Silv., *K. triceromegas* Silv., and *K. taurocephalus* Silv.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Winged imago.

Morphotype.—Soldier.

Described from many specimens of each caste taken from six different colonies at Kartabo by the author.

Kalotermes (Glyptotermes) guianensis, sp. nov.

(Fig. 33)

Imago.—Head medium light brown; widely oval, widest behind the eyes (eye not included); clothed with numerous bristles.

Antennae pale (broken in specimen).

Eyes large, nearly $\frac{1}{2}$ their diameter from the lower margin of the head.

Pronotum same color as the head; a little narrower than the head; sides rounded, posterior margin slightly rounded; clothed with numerous bristles.

Abdominal tergites same color as the head, clothed with numerous bristles.

Measurements.—

Length of head	1.38 mm.
Width of head	1.30 mm.
Length of pronotum	.69 mm.
Width of pronotum	1.05 mm.
Length of queen	6.40 mm.

Comparison with other species.—Very close to *K. taurocephalus* Silv., and may possibly be that species.

Soldier.—Head brownish yellow, darker in front; long, sides straight and parallel; forehead steep but not vertical, rather deeply lobed; clothed with a few bristles.

Antennae brownish yellow, with 11 or 12 segments.

Eyes unpigmented. Mandibles brownish black, fairly long and powerful; left with many teeth, right with teeth only on basal half.

Pronotum brownish yellow with a few bristles; about the same width as the head; sides rounded, posterior margin very slightly emarginate.

Abdominal tergites with a few bristles.

Measurements.—

Total length	5.20–5.59 mm.
Length of head	2.52–2.88 mm.
Width of head	1.18–1.25 mm.
Length of antennae	1.19 mm.
Length of pronotum	.59–.70 mm.
Width of pronotum	1.18–1.20 mm.
Length of hind tibia	.76–.88 mm.
Length of left mandible	1.12 mm.

Comparison with other species.—Very close to *K. taurocephalus* Silv., and may possibly be that species. A specimen determined by Holmgren, however, differs in having a little steeper forehead and a little thicker head. The den-
tation of the mandible in Silvestri's figure (1903) seems to be different also. *K. temnocephalus* Silv. is smaller. *K. triceromegas* Silv. according to Silvestri's figure (1903) has a proportionately shorter head.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Soldier.

Morphotype.—Dealated imago.

The description is based on a single dealated imago, the queen of a colony, and fifteen soldiers taken from two different colonies.

***Kalotermes (Glyptotermes) hospitalis* sp. nov.**

(Fig. 34)

Imago.—Head yellow, with numerous bristles; widely oval.

Antennae broken, 3d segment slightly larger than the 4th, 2d about equal to the 3d.

Eyes of medium size, about $\frac{4}{5}$ their diameter from the lower margin.

Ocelli of medium size, close to the eyes.

Pronotum yellow, with numerous bristles; a little narrower than the head; sides converging somewhat toward the rear, posterior margin not emarginate.

Wing scales brown, contrasting somewhat with the pronotum.

Abdominal tergites yellow, with numerous bristles.

Measurements.—

Length of head.....	1.46 mm.
Width of head.....	1.35 mm.
Diameter of eye.....	.31 mm.
Length of pronotum.....	.65 mm.
Width of pronotum.....	1.18 mm.
Length of queen.....	6.47 mm.

Soldier.—Head yellow brown, growing darker toward the front; clothed with numerous bristles; head long, sides straight and parallel; front sloping at an angle of about 45° , slightly lobed.

Antennae lighter than the head, with 11–12, rarely 13, segments; if with 11 segments, the 3d and 4th are equal, if with 12 segments, the 3d is conspicuously shorter than the 2d or 4th.

Eyes unpigmented, oval and small; about their length from the base of the antennae.

Mandibles black, the left with 3 small teeth, the right with 2 small teeth.

Pronotum nearly the same color as the head, with numerous bristles; sides nearly straight; posterior margin nearly straight.

Abdominal tergites with numerous bristles.

Measurements.—

Total length.....	5.88–9.00 mm.
Length of head.....	3.24–3.25 mm.
Width of head.....	1.53 mm.
Length of antennae.....	1.47–1.59 mm.
Length of pronotum.....	.65 mm.
Width of pronotum.....	1.29–1.47 mm.
Length of hind tibia.....	1.12–1.18 mm.
Length of left mandible.....	1.24 mm.

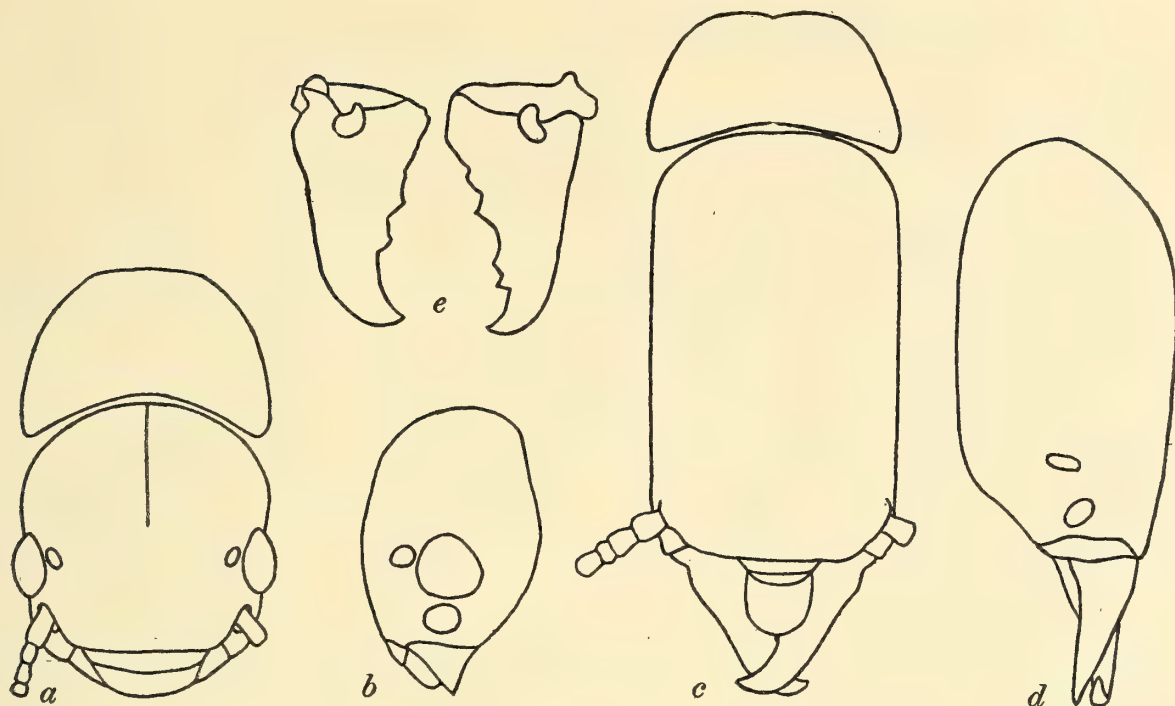


Fig. 34. *Kalotermes (Glyptotermes) hospitalis*, sp. nov. a, imago, dorsal view of head and pronotum; b, imago, lateral view of head; c, soldier, dorsal view of head and pronotum, d, soldier, lateral view of head; e, soldier, mandibles.

Comparison with other species.—*K. (Neotermes ?) latifrons* Silv. has a shorter and wider head.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Soldier.

Morphotype.—Queen.

Described from one queen and numerous soldiers collected by the author from a single colony at Kartabo. I am not sure that this species belongs to *Glyptotermes* because I have no winged specimen. It seems to come closest to this subgenus, however, so I am tentatively referring the species to *Glyptotermes*.

Subgenus *Lobitermes* Holmgren

Holmgren referred two species to this subgenus, one from Sarawak and the other from Argentine. If the species found at Kartabo is new, as I believe it is, the subgenus is thus represented by three species.

***Kalotermes (Lobitermes) nigriceps*, sp. nov.**

(Fig. 35) .

Imago.—Head dark brown, with numerous bristles; widely oval, thick; 2 round muscle insertions above the base of the antennae.

Antennae yellow brown with 13 segments.

Eyes fairly large, .17 mm. removed from the lower margin of the head.

Ocelli of medium size, close to the eyes. Labrum yellow-brown.

Pronotum dark brown with numerous bristles; as wide as the head; posterior margin very slightly emarginate, sides rounded. Pulvillus present.



Fig. 35. *Kalotermes (Lobitermes) nigriceps*, sp. nov. *a*, imago, dorsal view of head and pronotum; *b*, imago, lateral view of head; *c*, imago, wing; *d*, soldier, dorsal view of head and pronotum; *e*, soldier, lateral view of head; *f*, soldier, mandibles.

Wings dark; costal margin, radius, and media dark brown, cubitus indistinct; membrane stippled with brown dots. Costal margin ciliated, inner margin not ciliated. Two short veins run into the costal margin, one near the base, the other about $\frac{1}{5}$ the length of the wing from the base; costal margin, radius, and media run parallel without branches.

Abdominal tergites dark brown.

Measurements.—

Length with wings	6.82–8.00 mm.
Length without wings	4.35–5.20 mm.
Length of head	1.10–1.16 mm.
Width of head . . . . .	.94–1.01 mm.
Length of antennae	1.55–1.59 mm.
Diameter of eye . . . . .	.26 mm.
Length of pronotum . . . . .	.45–.53 mm.
Width of pronotum . . . . .	.88–.93 mm.
Length of anterior wing	5.18–5.30 mm.
Width of anterior wing	1.29–1.30 mm.

Comparison with other species.—The imago of *K. lobicephalus* Silvestri has never been adequately described. Holmgren (1911) gives subgeneric characters based upon *K. lobicephalus*, but his photographs do not give specific characters. Holmgren places *C. canellae* Fr. Müller as a synonym of *K. lobicephalus* but Müller's description (1873) is too meagre for determination.

Soldier.—Head entirely black or back of head yellowish brown with the front black; short; forehead nearly vertical and deeply lobed; sides straight and parallel; clothed with a few bristles; no sculpturing visible.

Antennae with 11 segments, the 3d very short, the 2d much longer than the 4th, which is a little longer than the 3d. Antennae yellow with the exception of the 1st and 2d segments.

Eyes visible in back of antennae bases if the head is not entirely black. Labrum nearly as dark as the head.

Mandibles black, short, and strongly toothed

Pronotum yellowish brown with numerous bristles; front margin deeply concave, hind margin widely emarginate, forming a longitudinal constriction in the middle; sides fairly straight, angles rounded.

Legs short; one of the 3 spines on the prothoracic tibia conspicuously larger than the other two; pulvillus absent.

Abdomen rather dull yellow. Sometimes the segments are outlined in black, in which case the head is always entirely black. Tergites with numerous bristles.

Measurements.—

Total length	3.80–4.40 mm.
Length of head	1.60–1.93 mm.
Width of head	1.15–1.24 mm.
Length of antennae . . . . .	.76–.96 mm.
Length of pronotum (middle) . . . . .	.39–.41 mm.
Width of pronotum	1.15–1.25 mm.
Length of hind tibia . . . . .	.64–.67 mm.
Length of left mandible . . . . .	.61 mm.

Comparison with other species.—Silvestri's description (1903) of the soldier of *K. lobicephalus* does not agree with this species. His measurements are uniformly larger and his figures are entirely different. However, photographs of *K. lobicephalus* in Holmgren (1911) are much closer, although there still seems to be a difference in the shape of the pronotum. The photograph of the soldier shows the hind margin of the pronotum rounded while in *K. nigriceps* it is widely emarginate.

A single soldier from a colony possessing a normal sized king and queen was found to be smaller, the width of the head being 1.03 mm. and other measurements proportionately smaller. I believe, however, that this was a young colony and the soldier was probably hatched from one of the first eggs laid by the queen.

Type locality.—Kartabo, British Guiana.

Other localities.—Barakara, British Guiana.

Range.—British Guiana.

Holotype.—Winged imago.

Morphotype.—Soldier.

Described from many specimens of winged imagos, kings, queens and soldiers collected by the author from six different colonies at Kartabo and one colony at Barakara.

Family RHINOTERMITIDAE Light

Holmgren (1911) divided this family (= Mesotermitidae) into six subfamilies, of which three, Leucotermitinae, Coptotermitinae, and Rhinotermitinae, are found in British Guiana.

Subfamily LEUCOTERMITINAE Holmgren

Holmgren (1911) included a single genus, *Leucotermes*, in this subfamily which he later (1913) divided into two subgenera, *Leucotermes*, s. str. and *Reticulitermes*. Banks (Banks & Snyder, 1920) later raised *Reticulitermes* to generic rank. No species of *Reticulitermes* has yet been recorded from South America except a soldier determined by Wasmann (1902) as a new subspecies of the common North American species, *Reticulitermes flavipes*. This record from Para, Brazil, may have been an introduction of a foreign species, or more likely, was a form of *Leucotermes*, s. str. Only the genus *Leucotermes* has been found in British Guiana.

Genus *Leucotermes* Silvestri

Formerly eight species of this genus have appeared in the literature. Also, there are two species recorded from the genus *Heterotermes* in Australia, the relationships of which seem to be close to *Leucotermes*. Upon examination of series from different parts of South America, Central America, and the West Indies, however, I have come to the conclusion that there are numerous more or less well defined species which have formerly been included under *Leucotermes tenuis* (Hagen). Dr. T. E. Snyder is working on this genus. Including the new species described in this report, the distribution of the genus is as follows:

Oriental region, four; Australian region, two (not including *Heterotermes*); Cocos Islands, one; Neotropical region, two (several more species undescribed).

Leucotermes tenuis (Hagen)

I am convinced that numerous species have been referred to this species in the literature and am therefore not publishing the complete synonymy until the Neotropical forms have been revised by Snyder.

Termes tenuis Hagen (1858), p. 231 (imago), pl. 3, fig. 35 (imago).
Termes tenuis Hagen (1858a), p. 33 (imago).

(Fig. 36, e, f, g)

Imago.—Head rather long, brownish yellow; oval; darker on top than on the sides, fontanelle and 2 pair of muscle insertions in front lighter in color; covered with long hairs.

Antennae with 17 segments, the 3d shorter than the 4th, the 4th shorter than the 2d; yellow.

Eyes rather small, somewhat triangular in shape with the corners rounded; .18 mm. from the lower margin of the head.

Ocelli rudimentary or absent. Labrum and clypeus yellow.

Pronotum covered with long hairs; borders darker than the top of the head,

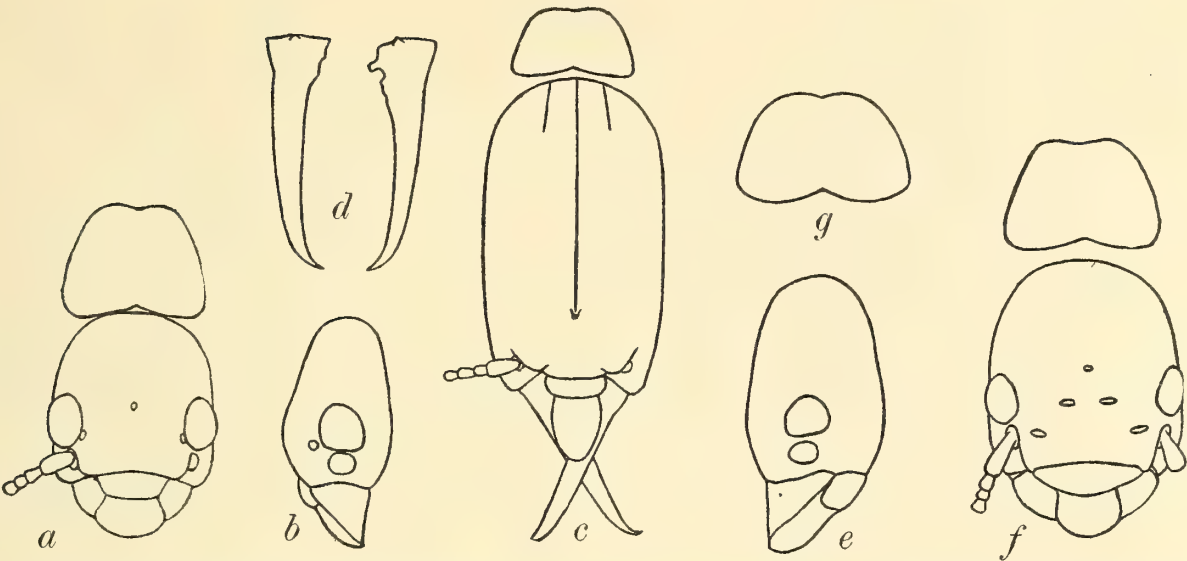


Fig. 36. *Leucotermes crinitus*, sp. nov. a, imago, dorsal view of head and pronotum; b, imago, lateral view of head; c, soldier, dorsal view of head and pronotum; d, soldier, mandibles.

Leucotermes tenuis (Hagen). e, imago, lateral view of head; f, imago, dorsal view of head and pronotum; g, soldier, pronotum.

the middle about the same color; anterior margin emarginate; sides converging posteriorly; posterior margin slightly emarginate.

In dealated specimens the front wing scales do not meet in the middle and the posterior margin of the mesonotum is clearly visible behind the wing scales. Posterior margins of the meso- and metanota somewhat emarginate. Wings yellow and cloudy. Legs yellow.

Abdominal tergites covered with long hairs, brownish yellow.

Measurements.—

Length with wings.....	10.64 mm.
Length without wings.....	5.32– 6.50 mm.
Length of head.....	1.29 mm.
Width of head.....	1.00– 1.03 mm.
Length of antennae.....	2.09 mm.
Diameter of eye.....	.28 mm.
Length of pronotum.....	.52 mm.
Width of pronotum.....	.80 mm.
Length of hind tibia.....	1.03 mm.
Length of anterior wing.....	8.27 mm.
Width of anterior wing.....	2.13 mm.

Soldier.—Head yellow; long; sides parallel, slightly rounded; head covered with hairs sparsely scattered.

Antennae with 15–17 segments.

Mandibles dark reddish brown; inner margins smooth except near the base, where a few small teeth occur.

Frontal gland visible as a small dark spot in the middle of the forehead.

Pronotum yellow; front margin emarginate, hind margin slightly emarginate; sides and angles rounded; rather sparsely covered with hair. Legs yellow.

Abdomen yellow; tergites rather sparsely covered with hair.

Measurements.—

Total length	5.55–5.91 mm.
Length of head	2.41–2.80 mm.
Width of head . . . . .	.93–1.07 mm.
Length of antennae	1.61–1.70 mm.
Length of pronotum . . . . .	.42–.48 mm.
Width of pronotum . . . . .	.71–.93 mm.
Length of hind tibia . . . . .	.81–.83 mm.
Length of left mandible	1.16–1.25 mm.

Comparison with other species.—Differs markedly from *L. crinitus* in having fewer hairs on the head of the soldier. The imago has smaller eyes.

Type locality.—Brazil (Hagen's collection at the Museum of Comparative Zoology at Cambridge, Mass.).

New localities.—Kartabo, British Guiana; Dunoon, British Guiana.

Range.—Brazil, British Guiana, Colombia, Panama, West Indies, Bolivia, Peru, Paraguay, Argentina, St. Helena. (It is probable that several species are included in these various records and therefore the range needs accurate revision.)

The description is based on examination of numerous winged imagos and soldiers collected by Mr. John Tee-Van and the author at Kartabo from four different colonies, and from numerous soldiers from a single colony collected by Mr. F. M. Gaige at Dunoon. Dr. T. E. Snyder kindly compared specimens from Kartabo with the type imago from Brazil in the Hagen Collection. Although the type was dried, there seemed to be little doubt that the specimens belong to the same species.

***Leucotermes crinitus*, sp. nov.**

(Fig. 36, *a*, *b*, *c*, *d*)

Imago.—Head yellow, slightly brownish on top; long, oval and high above the eyes, forming a hump; several muscle insertions visible as light dots; fontanelle rather inconspicuous, but visible as a light dot. Head thickly covered with long hairs.

Antennae with 17 segments, 3d slightly smaller than the 4th, 4th shorter than the 2d.

Eyes of medium size, front margin somewhat straight.

Ocelli barely visible as light dots near the eyes.

Pronotum same color as the head; front and hind margins emarginate; sides fairly straight; angles rounded.

Forewing scales nearly touch in the middle, their posterior margins making nearly an even continuous line across the thorax; nearly or just cover the hind margin of the mesonotum; hind margins of meso- and metanota very slightly emarginate. Wings yellow and cloudy. Abdominal tergites yellow.

Measurements.—

Length of head	1.35 mm.
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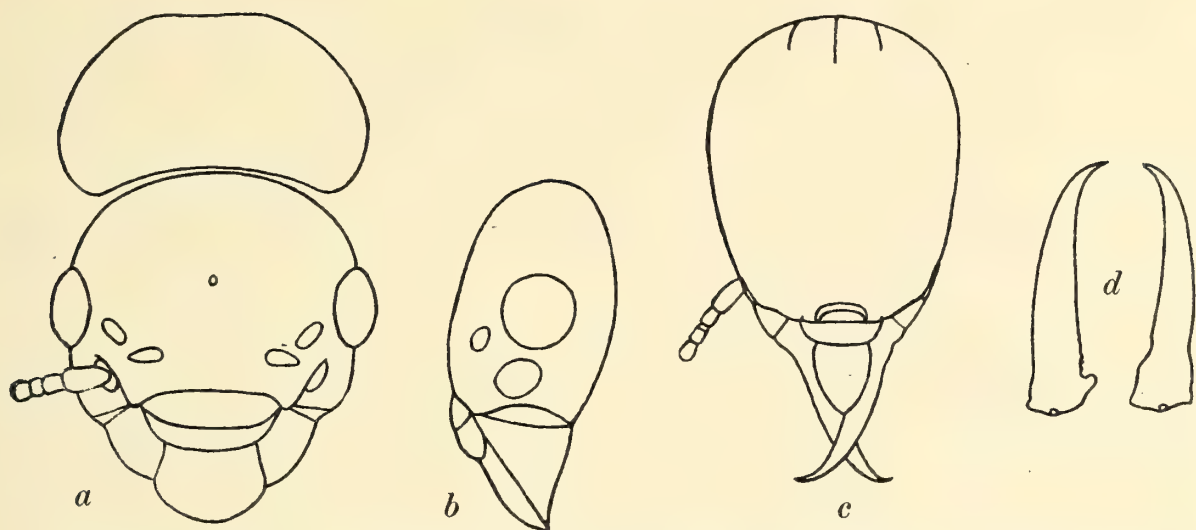


Fig. 37. *Coptotermes marabitanas* (Hagen). *a*, imago, dorsal view of head and pronotum; *b*, imago, lateral view of head; *c*, soldier, dorsal view of head; *d*, soldier, mandibles.

Measurements.—

Width of head.....	1.12 mm.
Length of antennae.....	2.15 mm.
Diameter of eye.....	.32 mm.
Length of pronotum.....	.58 mm.
Width of pronotum.....	.87 mm.
Length of hind tibia.....	1.09 mm.
Length of anterior wing.....	9.10 mm.
Width of anterior wing.....	2.55 mm.

Comparison with other species.—Measurements uniformly larger than in *L. tenuis*. Eye is proportionately larger, pilosity greater and forewing scales form a continuous line across the thorax. The color is also lighter on the head, pronotum and abdomen than in *L. tenuis*.

Soldier.—Very similar to *L. tenuis*, but differs in the head being much more thickly covered with hair. The anterior angles of the pronotum are also much sharper. The soldiers vary somewhat in size.

Measurements.—

Total length.....	6.15 mm.
Length of head.....	2.73 mm.
Width of head.....	1.22 mm.
Length of antennae.....	1.61 mm.
Length of pronotum.....	.39 mm.
Width of pronotum.....	.80 mm.
Length of hind tibia.....	.77 mm.
Length of left mandible.....	1.22 mm.

Type locality.—Kartabo, British Guiana.
Range.—Known only from the type locality.
Holotype.—Winged imago.
Morphotype.—Soldier.

Described from many winged imagos and numerous soldiers collected by the author at Kartabo from four different colonies.

Subfamily COPTOTERMITINAE Holmgren

Holmgren (1911) included two genera, *Prorhinotermes* (= *Arrhinotermes*) and *Coptotermes*, in this subfamily. Only *Coptotermes* has been found in British Guiana.

Wasmann (1902) described the genus *Arrhinotermes* for one species, *A. heimi*, which belongs to *Coptotermes*. Therefore *Arrhinotermes* is synonymous with *Coptotermes* in spite of the fact that another species, *A. oceanicus*, was also included as a species of *Arrhinotermes* by Wasmann. *A. oceanicus* was left without a generic name and as it is a *Prorhinotermes*, a genus described by Silvestri in 1909, it must be included in that genus, although it was not mentioned by Silvestri in his original description.

Genus *Coptotermes* Wasmann

There are twenty-nine species and two varieties of this genus recorded in the literature. These are distributed as follows: Oriental region twelve, Australia and New Guinea nine, Africa and Madagascar four species and two varieties, and South and Central America four. One species, *C. testaceus*, has never been described adequately and may not be valid.

One species was common at Kartabo and does considerable damage to buildings in Georgetown.

Coptotermes marabitanas (Hagen).

Termes Marabitanas Hagen (1858), p. 191 (imago, soldier), pl. 1, fig. 4 (soldier), pl. 3, fig. 25 (imago).

Termes Marabitanas Hagen (1858a), p. 26 (imago).

Coptotermes marabitanas Silvestri (1901), p. 4.

Coptotermes marabitanas Silvestri (1903), p. 46 (imago, soldier, worker), p. 115 (biology), pl. 2, figs. 70-72 (soldier), figs. 73-74 (worker).

Coptotermes marabitanas Desneux (1915), p. 7 (locality).

Coptotermes marabitanas Banks (1918), p. 662 (locality).

(Fig. 37)

Imago.—Head brownish black with long hairs; widely oval; fontanelle small; two large indistinct muscle insertions in front of the ocelli; mandibles yellowish.

Antennae with 19-20 segments, 3d shorter than the 4th, 4th shorter than the 2d.

Eyes small, about $\frac{1}{3}$ their diameter (.13 mm.) from the lower margin of the head.

Ocelli of medium size (.14 mm. long), less than their length from the eyes (.08 mm.).

Clypeus yellowish; posterior portion short; median groove present but no median line visible.

Pronotum brownish black with long hairs, usually narrower than the head but sometimes wider.

Hind margins of meso- and metanota very slightly emarginate; angles rounded.

Wings dark smoky; scales with long hairs; margins of wings ciliated; membrane covered with short hairs; veins rather distinct.

Abdominal tergites brown; sternites yellow to brown.

Measurements.—

Length with wings	13.59–16.00 mm.
Length without wings	7.94– 9.00 mm.
Length of head	1.61– 1.82 mm.
Width of head	1.48– 1.56 mm.
Length of antennae	2.57– 2.94 mm.
Diameter of eye . . . . .	.38 mm.
Length of pronotum . . . . .	.81– .96 mm.
Width of pronotum	1.38– 1.51 mm.
Length of hind tibia	1.38 mm.
Length of anterior wing	11.35–11.82 mm.
Width of anterior wing	3.31– 3.56 mm.

Comparison with other species.—Seems to vary considerably in size, proportion of pronotum to head, and color of sternites. I can find no good character to separate this species from Hagen's description of *C. testaceus* and it is possible that they are the same species. *C. marabitanas* is distinguished from *C. niger* Snyder in the ocelli being less than their length from the eye.

Soldier.—Head yellow with sparsely scattered erect bristles; oval, narrowing toward the front.

Antennae pale, with 14 segments.

Labrum with rounded sides; and pointed; widest near the base.

Mandibles red brown, long, pointed; ends curved; the inner edges smooth except near the base. Left mandible with a conspicuous rounded tooth near the base and 4 dentations immediately in front of it. The right mandible with no teeth or dentations.

Gland opening large, near the base of the clypeus.

Pronotum yellow with long bristles on the margins; anterior margin emarginate, posterior margin very slightly emarginate; sides converging toward the rear; angles rounded. Abdomen pale.

Measurements.—

Total length	3.88–6.00 mm.
Length of head	2.09–2.23 mm.
Width of head	1.06–1.20 mm.
Length of antennae	1.77 mm.
Length of pronotum . . . . .	.35– .48 mm.
Width of pronotum . . . . .	.53– .77 mm.
Length of hind tibia . . . . .	.90–1.06 mm.
Length of left mandible . . . . .	.94– .96 mm.

Comparison with other species.—*C. niger* Snyder is difficult to distinguish from this species.

Type locality.—St. Jose de Marabitanas, Brazil.

New localities.—Upper Wenamu River, Lower Cuyuni River, Dunoon, Georgetown and Kartabo, British Guiana; Port of Spain, Trinidad.

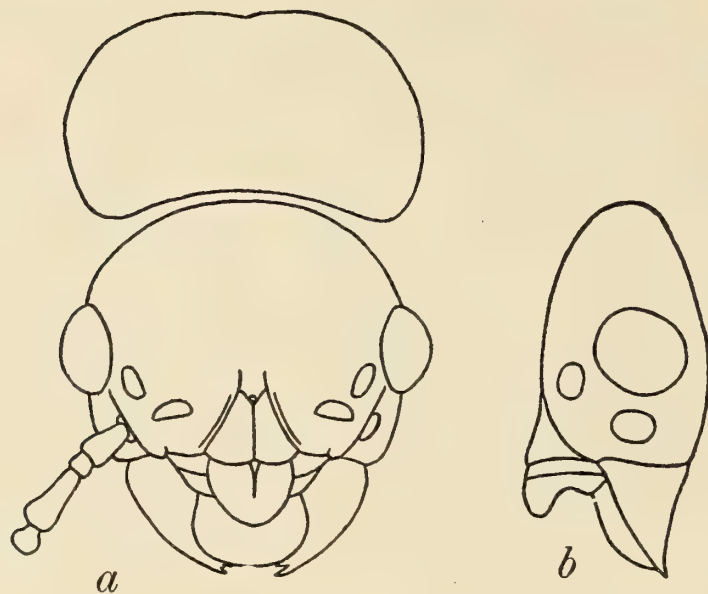


Fig. 38. *Rhinotermes (Rhinotermes) nasutus* (Perty). . *a*, imago, dorsal view of head and pronotum; *b*, imago, lateral view of head.

Range.—Brazil, British Guiana, Trinidad, Panama.

Description based upon many winged imagos and many soldiers collected in various localities from numerous colonies as follows: Winged imagos from Upper Wenamu collected by Lavarre, winged imagos from Lower Cuyuni River collected by Lavarre; numerous soldiers and workers collected by F. M. Gaige at Dunoon; many soldiers, winged imagos and workers collected by the author at Georgetown; many winged imagos, soldiers, and workers collected at Kartabo by the author; and numerous soldiers and workers collected at Port of Spain by the author.

Subfamily RHINOTERMITINAE Froggatt

Holmgren (1911) included two genera in this subfamily. Of these two genera one, *Parrhinotermes*, is known from the Oriental and Australian regions only. The other genus, *Rhinotermes*, has a wide distribution and is well represented in British Guiana.

Genus *Rhinotermes* (Hagen)

Holmgren (1911 & 1913) has divided this genus into three subgenera. Of these one, *Schedorhinotermes*, has been raised to generic rank by Silvestri. The subgenus *Macrorhinotermes* is known only from a single species from South-east Borneo. The subgenus *Schedorhinotermes* contains fifteen known species and one subspecies distributed as follows: Oriental region eight, Africa three, and Australian region, including German New Guinea and the Bismarck Archipelago, four species and one subspecies. The subgenus *Rhinotermes*, s. str. is known only from the Neotropical region.

Subgenus *Rhinotermes* Hagen

This subgenus has been known for many years only from two species, *R. marginalis* (L.) and *R. nasutus* (Perty). It was rather surprising, therefore, to find six well defined species at Kartabo, four of which I am describing as new, and two of which I refer to *R. marginalis* and *R. nasutus*. This subgenus is of particular interest because of the remarkable dimorphism exhibited in the soldier caste.

Rhinotermes (*Rhinotermes*) *nasutus* (Perty).

Termes nasutus Perty (1830), p. 127, pl. 25, fig. 10 (imago).

Termes nasutus Hagen (1858), p. 237 (imago), pl. 2, fig. 14, pl. 3, fig. 1 (imago).

Termes nasutus Hagen (1858a), p. 33 (imago).

Rhinotermes taurus Desneux (1904), p. 146 (soldier).

Rhinotermes taurus Holmgren (1906), p. 531 (imago, soldier, worker), text-fig. B (imago), text-fig. C (major soldier), text-fig. D (minor soldier), text-fig. E (worker).

Rhinotermes taurus Holmgren (1909), p. 94 (anatomy), p. 95, fig. 27 (worker), fig. 28 (major soldier), p. 96, figs. 29, 30 (minor soldier).

Rhinotermes (*Rhinotermes*) *nasutus* Holmgren (1911), p. 80 (synonymy), pl. 6, fig. 6 (major soldier), fig. 7 (minor soldier).

Rhinotermes nasutus Holmgren (1912), p. 19, text-fig. 2 (mandibles of major soldier).

(Fig. 38)

Imago.—Head orange yellow with a number of bristles; round; two large conspicuous muscle insertions in front of the ocelli.

Antennae yellow orange; with 20 segments, the 3d very large and long, three times the length of the 2d and conspicuously longer than the 1st, enlarged at the tip.

Eyes rather large, $\frac{1}{4}$ their diameter from the lower margin.

Ocelli rather large, less than their diameter from the eyes.

Clypeus projecting as in other members of this subgenus.

Thorax with numerous bristles. Pronotum orange yellow, nearly as wide as the head; sides rounded; posterior margin slightly emarginate. Posterior margins of meso- and metanota straight.

Wings hyaline, base brownish near the suture; reticulated.

Legs orange yellow. Abdomen orange yellow with numerous bristles.

Measurements.—

Length with wings	18.91 mm.
Length without wings	10.00–11.00 mm.
Length of head	2.47– 2.57 mm.
Width of head	2.28– 2.35 mm.
Length of antennae	3.85 mm.
Diameter of eye . . . . .	.65 mm.
Length of pronotum	1.25– 1.28 mm.
Width of pronotum	2.12– 2.15 mm.
Length of hind tibia	2.70– 2.73 mm.
Length of anterior wing	14.18 mm.
Width of anterior wing	4.02 mm.

Comparison with other species.—Differs from *R. marginalis* in being lighter

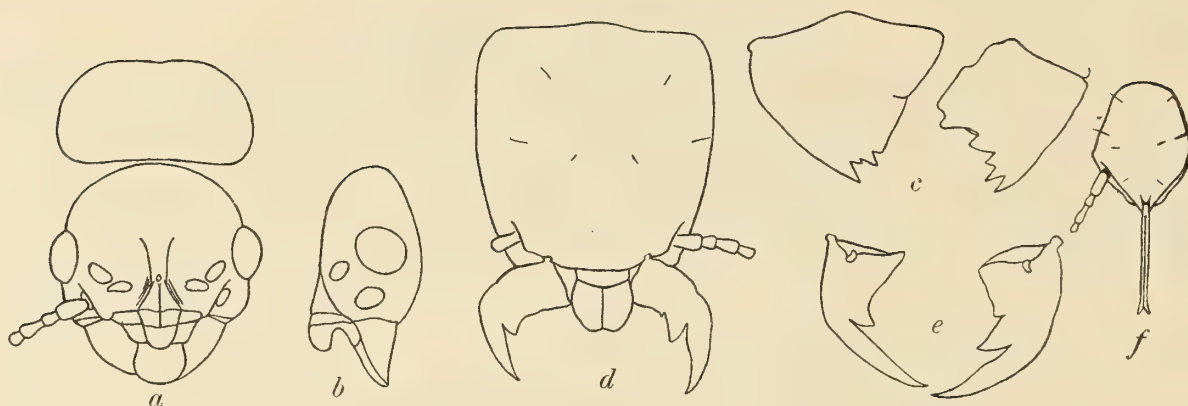


Fig. 39. *Rhinotermes (Rhinotermes) marginalis* (L.) (Hagen). *a*, imago, dorsal view of head and pronotum; *b*, imago, lateral view of head; *c*, imago, mandibles; *d*, major soldier, dorsal view of head; *e*, major soldier, mandibles; *f*, minor soldier, dorsal view of head.

in color, of larger size, and the 3d segment of the antennae is conspicuously larger than the 1st segment.

Type locality.—Northern Brazil.

New localities.—British Guiana; Issororo, Kartabo.

Range.—Peru, Northern Brazil, Surinam, British Guiana.

Described from three winged imagos, one collected at Issororo, British Guiana, by G. E. Bodkin, the other two collected by the author on different occasions at Kartabo.

Rhinotermes (Rhinotermes) marginalis (Linné) Hagen.

Hemerobius marginalis Linnaeus (1758), *ed.* 10, p. 550; *ed.* 12, p. 912.

Perla nasuta Degeer (1778), p. 568; *ed.* Goetze, p. 367; *ed.* Retzius (1783), p. 60.

Termes nasutum Latreille (1805), p. 69; (1805a), p. 61.

Termes nasutus Burmeister (1839), p. 764.

Termes (Rhinotermes) marginalis Hagen (1858), p. 234 (imago).

Termes marginalis Hagen (1858a), p. 33 (imago).

Rhinotermes marginalis Holmgren (1906), p. 537–539 (imago, minor soldier, worker), *text-fig.* F (imago).

Rhinotermes marginalis Holmgren (1909), p. 93 (anatomy), p. 94, *fig.* 25, 26 (imago).

Rhinotermes (Rhinotermes) marginalis Holmgren (1911), *pl.* 6, *fig.* 5 (imago).

Rhinotermes marginalis Banks (1918), p. 666 (locality).

Rhinotermes marginalis Banks (1919), p. 480 (major soldier, minor soldier), *pl.* 1, *fig.* 1 (major soldier), *fig.* 5 (minor soldier).

(Fig. 39)

Imago.—Head brown, back of head and around antennae bases lighter; clothed with a few long bristles; round; two large muscle insertions in front of the ocelli.

Antennae with the 3d segment about twice the length of the 2d and about the same length as the 1st, enlarged at the tip.

Eyes fairly large; about $\frac{1}{4}$ their diameter from the lower margin of the head.

Ocelli large, less than their length from the eyes.

Clypeus lighter than the head, conspicuously projecting.

Pronotum a little lighter than the head with an inconspicuous light T-shaped mark in the middle; clothed with numerous bristles; sides rounded, posterior margin very slightly emarginate.

Wings hyaline, not as distinctly pigmented near the suture as in *R. nasutus*; wing membranes and margins entirely free from hairs and pigment spots. Legs yellow.

Abdominal tergites brown, a little darker than the pronotum.

Measurements.—

Length with wings.....	14.50–15.60 mm.
Length without wings.....	8.50–10.00 mm.
Length of head.....	1.90– 2.00 mm.
Width of head.....	1.90– 1.96 mm.
Diameter of eye.....	.51– .53 mm.
Length of pronotum.....	.93– 1.00 mm.
Width of pronotum.....	1.60– 1.78 mm.
Length of hind tibia.....	2.40– 2.70 mm.
Length of anterior wing.....	10.28–11.00 mm.
Width of anterior wing.....	3.31– 3.41 mm.

Comparison with other species.—The imago is smaller in size and darker in color than *R. nasutus*; the 3d segment of the antennae is about the same length as the 1st and the pronotum is somewhat smaller in proportion to the head.

Major soldier.—Light reddish yellow. Head clothed with a few sparsely scattered bristles; somewhat rectangular, sides somewhat rounded, hind margin slightly bow-shaped.

Antennae with 17 segments, the 3d conspicuously longer than the 2d or 4th, the 4th very slightly longer than the 2d.

Labrum rather wide, rounded at the tip and grooved in the middle.

Mandibles dark red brown with long, sharp, slightly curved points. Left mandible with one large tooth in the middle of the inner edge and a much smaller tooth just behind the first. Right mandible with a single large tooth in the middle of the inner margin.

Pronotum with a few long bristles; sides rounded, hind margin emarginate.

Measurements.—

Total length.....	6.50 mm.
Length of head.....	3.37 mm.
Width of head.....	1.99–2.12 mm.
Length of antennae.....	2.47 mm.
Length of pronotum.....	.64 mm.
Width of pronotum.....	1.28 mm.
Length of hind tibia.....	1.99 mm.
Length of left mandible.....	1.41 mm.

Comparison with other species.—The specimens agree with both Holmgren’s description of *R. nasutus* and Banks’ description of *R. marginalis*.

Minor soldier.—Body entirely reddish yellow. Head with about 8 long bristles scattered over it; widest in the middle; very slightly constricted toward the rear.

Antennae with 15–16 segments (usually 16), the 3d conspicuously longer than the 4th, the 4th slightly longer than the 2d.

Measurements.—

Total length	3.78 mm.
Length of head	1.54–1.77 mm.
Width of head	.67–.70 mm.
Length of antennae	2.25 mm.
Length of pronotum	.35 mm.
Width of pronotum	.55 mm.
Length of hind tibia	1.19 mm.

Type locality.—America.

New localities.—British Guiana, Kartabo, Dunoon; Martinique, W. I.

Range.—Peru, Surinam, British Guiana, Martinique, Haiti.

Remarks.—Unfortunately no single colony with imagos, major soldiers, and minor soldiers was found. Therefore I am not absolutely certain that the major soldiers described here belong to the imago. However, minor soldiers found with the imago and minor soldiers found with the major soldiers agree so closely that I feel little doubt that all the castes belong to a single species.

The descriptions are based upon several winged specimens collected by the author at Kartabo; many dealated specimens, some of which were found with young colonies containing workers and minor soldiers of a small size, all collected at Kartabo by the author; many major soldiers from several different colonies collected by the author at Kartabo; many minor soldiers also collected at Kartabo, often with major soldiers; numerous major soldiers collected by F. M. Gaike at Dunoon; and a few major and minor soldiers collected in Martinique by the author.

***Rhinotermes (Rhinotermes) hispidus*, sp. nov.**

(Fig. 40)

Major soldier.—Entire body light reddish yellow. Head covered with bristles, many more than in *R. marginalis*. Head somewhat rectangular; sides nearly straight; hind margin slightly bow-shaped.

Antennae with 16 segments, the 3d conspicuously longer than the 2d, the 2d equal to the 4th.

Labrum proportionately wide, tip rounded, a groove in the middle.

Mandibles dark red brown except at the base. Left mandible with 2 teeth, the 1st larger than the 2d. Right mandible with 2 teeth, the 1st smaller than the 2d, more separated than the teeth of the left mandible.

Pronotum with numerous bristles, sides rounded, hind margin only very slightly emarginate.

Measurements.—

Total length	6.15–7.68 mm.
Length of head	3.21–3.55 mm.
Width of head	1.83–1.96 mm.
Length of antennae	2.41 mm.
Length of pronotum	.64–.67 mm.
Width of pronotum	1.16–1.22 mm.

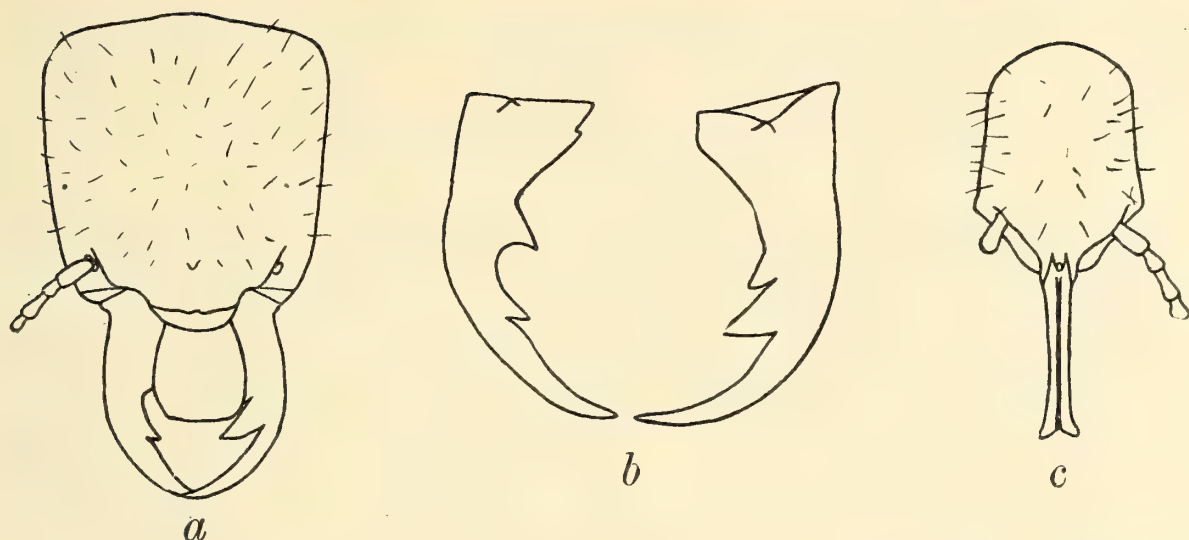


Fig. 40. *Rhinotermes (Rhinotermes) hispidus*, sp. nov. a, major soldier, dorsal view of head; b, major soldier, mandibles; c, minor soldier, dorsal view of head.

Measurements.—

Length of hind tibia.....	1.70–1.86 mm.
Length of left mandible.....	1.55–1.67 mm.

Comparison with other species.—Differs from *R. marginalis* and *R. nasutus* in the large number of bristles found on the head and the dentation of the mandibles.

Minor soldier.—Head with numerous bristles, many more than in *R. marginalis*. The head is not as constricted toward the rear as in *R. subfusciceps*. Antennae with 15–16 segments (type specimen with 15 segments), the 3d usually not longer than the 2d or 4th. The specimens from different colonies vary considerably, but as the major soldiers do not differ I feel sure that only one species is represented.

Measurements.—

Total length.....	3.90 mm.
Length of head.....	1.70–1.93 mm.
Width of head.....	.74–.83 mm.
Length of antennae.....	1.83–2.41 mm.
Length of pronotum.....	.38–.48 mm.
Width of pronotum.....	.61–.74 mm.
Length of hind tibia.....	1.16–1.28 mm.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Major soldier.

Morphotype.—Minor soldier.

The descriptions are based upon numerous major and minor soldiers collected from two different colonies by the author at Kartabo. Although no soldiers were found with *R. nasutus* and no imagos found with *R. hispidus*,

I hardly think it possible that these are the same species, because the descriptions of the soldiers of *R. nasutus* in the literature are very different from this species.

Rhinotermes (Rhinotermes) longilabius, sp. nov.

(Fig. 41)

Imago.—Head brown, yellow around the base of the antennae; mandibles with dark borders; head clothed with a few long bristles; round; two large conspicuous muscle insertions in front of the ocelli. Fontanelle small, on a line between the ocelli. Front of head raised to meet the base of the clypeus; several dark wrinkles sloping away from in front of the fontanelle.

Antennae yellow, with 20 segments, the 2d, 3d, and 4th about equal in length.

Eyes rather large, $\frac{2}{5}$ their diameter from the lower margin of the head.

Ocelli small, less than their diameter from the eyes.

Clypeus yellow, prolonged above the labrum, proportionately wide at the base; a groove extending along the median line.

Pronotum brown with a light T-shaped mark in the middle; same width as the head; clothed with a few long bristles.

Posterior margins of the meso- and metanota nearly straight.

Wings dark and reticulated.

Abdominal tergites brown. Sternites yellow tinged with brown. Tergites with many bristles.

Measurements.—

Length with wings	8.00– 8.50 mm.
Length without wings	5.50– 5.80 mm.
Length of head	1.29– 1.50 mm.
Width of head	1.28– 1.29 mm.
Length of antennae	2.35 mm.
Diameter of eye . . . . .	.29 mm.
Length of pronotum . . . . .	.50– .59 mm.
Width of pronotum	1.06– 1.07 mm.
Length of anterior wing	5.36– 5.59 mm.
Width of anterior wing	1.85– 2.00 mm.
Length of queen	12.50 mm.

Comparison with other species.—Differs from *R. tenebrosus* in the lighter colored sternites and the conspicuous T-shaped mark on the pronotum.

Major soldier.—Head yellow with numerous bristles, broadest in back.

Antennae pale, with 16 segments, the 3d slightly longer than the 2d or 4th.

Labrum elongated, nearly reaching the tip of the mandibles; tip slightly emarginate.

Mandibles large. Left mandible with 2 large pointed teeth, the 2d somewhat smaller than the 1st, a very small 3d tooth also visible near the base. Right mandible with one large double pointed tooth, the 1st point on the anterior side and the 2d point at the apex of the tooth; a 3d microscopic tooth is also present nearer the base.

Pronotum yellow, with numerous bristles. Legs pale. Abdomen yellow.

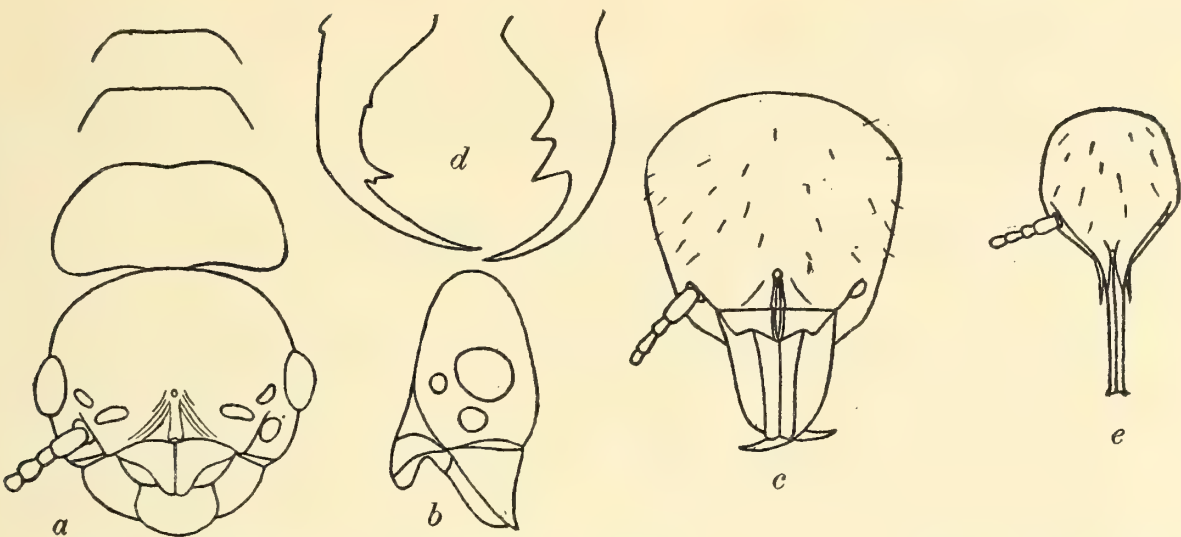


Fig. 41. *Rhinotermes (Rhinotermes) longilabius*, sp. nov. a, imago, dorsal view of head, pronotum and margins of thoracic nota; b, imago, lateral view of head; c, major soldier, dorsal view of head; d, major soldier, mandibles; e, minor soldier, dorsal view of head.

Measurements.—

Total length.....	3.65–4.10 mm.
Length of head.....	1.65–1.76 mm.
Width of head.....	1.06–1.10 mm.
Length of antennae.....	1.53–1.55 mm.
Length of pronotum.....	.35– .38 mm.
Width of pronotum.....	.65– .66 mm.
Length of hind tibia.....	.65– .76 mm.
Length of left mandible.....	.70– .75 mm.

Comparison with other species.—Easily distinguished from *R. tenebrosus* by the difference in the dentation of the mandibles and the yellow color.

Minor soldier.—Head, thorax, and abdomen yellow, legs and antennae pale. Head, thorax and abdomen with numerous bristles. Head widest behind the antennae; posterior margin rounded. Labrum elongated, narrow, forked at the tip. Mandibles vestigial. Antennae with 14 segments (specimen from a young colony with 12 segments).

Measurements.—

Total length.....	2.35–3.50 mm.
Length of head.....	1.10–1.12 mm.
Width of head.....	.53 mm.
Length from the tip of the labrum to the fontanelle.....	.53 mm.
Length of antennae.....	1.28–1.29 mm.
Length of hind tibia.....	.45– .59 mm.
Length of pronotum.....	.22– .23 mm.
Width of pronotum.....	.40– .41 mm.

Type locality.—Kartabo, British Guiana.
Range.—Known only from the type locality.

Holotype.—Major soldier.

Morphotype.—Winged imago.

The descriptions are based on many specimens of each caste collected from twelve different colonies at Kartabo by the author.

Rhinotermes (Rhinoctermes) tenebrosus, sp. nov.

(Fig. 42)

Imago.—Head dark brown with numerous long bristles; broadly oval.

Antennae yellow with 20 segments, the 2d equal to the 3d, the 3d a little larger than the 4th.

Eyes of medium size, about $\frac{1}{2}$ their diameter from the lower margin.

Ocelli small, slightly larger than the fontanelle, a little more than their length from the eyes.

Tip of clypeus yellow, projecting; rounded at the tip.

Pronotum dark brown, margin with numerous long bristles; much narrower than the head, sides rounded, posterior margin slightly emarginate. Legs yellow.

Wings dark smoky, lacking marginal cilia; media and cubitus indistinct, merged with irregular thickenings to form a reticulate pattern.

Abdominal tergites dark brown with many bristles. Sternites brown, contrasting strongly with yellow thorax and legs.

Measurements.—

Length with wings.....	8.53–8.82 mm.
Length without wings.....	5.00–5.88 mm.
Length of head.....	1.29–1.35 mm.
Width of head.....	1.18–1.24 mm.
Length of antennae.....	2.35–2.41 mm.
Diameter of eye.....	.24 mm.
Length of pronotum.....	.59 mm.
Width of pronotum.....	.93–1.00 mm.
Length of hind tibia.....	1.45 mm.
Length of anterior wing.....	5.88–6.06 mm.
Width of anterior wing.....	1.82 mm.

Comparison with other species.—This species can be distinguished from *R. longilabius* by the dark sternites, the pronotum being proportionately smaller than the head, and the T-shaped mark on the pronotum is not as conspicuous as in *R. longilabius*.

Major soldier.—Head brown, covered with numerous erect bristles; longer than broad, a little wider behind than in front; posterior margin rounded.

Antennae pale, with 16 segments, the 3d longer than the 2d or 4th. Labrum narrow and elongate reaching at least $\frac{2}{3}$ the length of the mandibles, rounded at the tip.

Mandibles large and powerful. The left with 2 large teeth rather far apart and a third inconspicuous microscopical tooth near the base; the 1st tooth much larger than the 2d. Right mandible with 2 large teeth and a 3d distinct

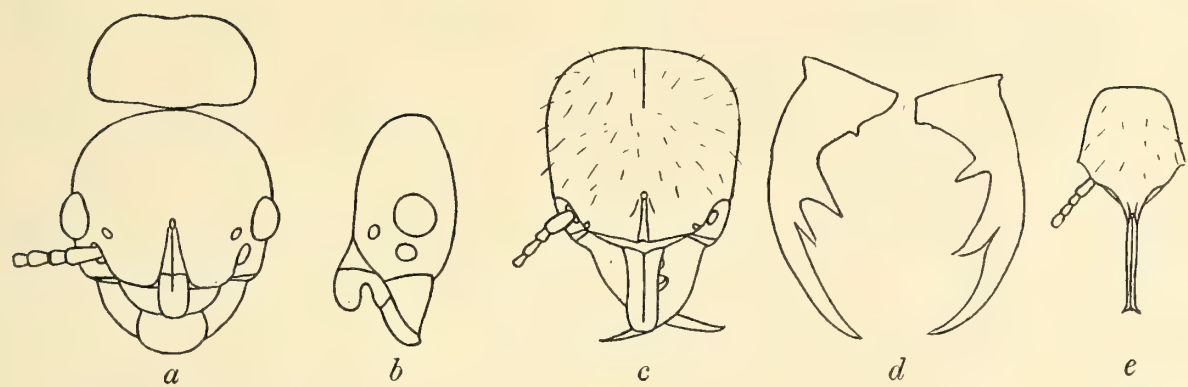


Fig. 42. *Rhinotermes (Rhinotermes) tenebrosus*, sp. nov. a, imago, dorsal view of head and pronotum; b, imago, lateral view of head; c, major soldier, dorsal view of head; d, major soldier, mandibles; e, minor soldier, dorsal view of head.

small tooth near the base; a rounded angle between the 1st and 2d teeth, the 2d tooth much larger than the 1st.

Pronotum brown, covered with numerous bristles. Legs pale.
Abdominal tergites covered with numerous bristles.

Measurements.—

Total length.....	3.70–5.80 mm.
Length of head.....	1.76–2.03 mm.
Length of head to tip of labrum.....	1.65–1.73 mm.
Width of head.....	1.10–1.12 mm.
Length of antennae.....	1.71–1.82 mm.
Length of pronotum.....	.35– .38 mm.
Width of pronotum.....	.64– .71 mm.
Length of hind tibia.....	1.00–1.12 mm.
Length of left mandible.....	.95–1.00 mm.

Comparison with other species.—Easily distinguished from all other known major soldiers by the dentation of the mandibles.

Minor soldier.—Head, thorax, and abdominal tergites brown, with numerous bristles. Legs and antennae pale. Head widest behind the antennae, sides converging toward the rear. Posterior margin of the head rounded. Labrum very elongate, narrow, forked at the tip. Mandibles vestigial. Antennae with 15–16 segments.

Measurements.—

Total length.....	3.43–3.80 mm.
Length of head.....	1.47–1.50 mm.
Width of head.....	.64– .70 mm.
Length of antennae.....	1.71–1.76 mm.
Length of labrum.....	.75– .76 mm.
Length of hind tibia.....	.75– .82 mm.
Length of pronotum.....	.32– .35 mm.
Width of pronotum.....	.42– .53 mm.

Type locality.—Kartabo, British Guiana.
Range.—Known only from the type locality.
Holotype.—Major soldier.
Morphotype.—Winged imago.

The descriptions are based upon many specimens of all the castes collected at Kartabo by the author from six different colonies.

Rhinotermes (Rhinotermes) subfusciceps, sp. nov.

(Fig. 43)

Imago (one queen).—Head reddish yellow, widely oval, with a few long bristles.

Antennae broken, the 3d segments longer than the 2d or 4th and not as long as the 1st, the 2d equal to the 4th.

Eyes of medium size, .13 mm. from the lower margin; oval in shape.

Ocelli of medium size, oval, about their length removed from the eyes.

Clypeus projecting, from the side appearing to be pointed at the tip.

Pronotum reddish yellow with numerous long bristles; sides and posterior margin making nearly a perfect semicircle; posterior margin not emarginate.

Wing scales brownish yellow. Abdomen brownish yellow.

Measurements.—

Length of head.....	1.51 mm.
Width of head.....	1.35 mm.
Diameter of eye.....	.32 mm.
Length of pronotum.....	.67 mm.
Width of pronotum.....	1.06 mm.
Length of queen.....	8.27 mm.

Comparison with other species.—Much smaller than *R. nasutus* or *R. marginalis*. Larger and lighter in color than *R. tenebrosus* or *R. longilabius*.

Minor soldier.—Head golden brown, contrasting somewhat with the abdomen. Head somewhat constricted behind, making the sides concave; widest in front of the middle; clothed with a number of bristles. A tubercle is visible in back of the base of each antenna.

Antennae with 15 segments, the 3d longer than the 2d or 4th and a little enlarged at the tip, the 2d equals the 4th.

Labrum much elongated, thin, forked at the tip; a groove extending down the middle. Mandibles vestigial but visible as sharp points beneath the labrum.

Pronotum nearly the same color as the head, widest portion in the middle; posterior margin not emarginate; front prolonged somewhat into a wide lobe. Abdomen reddish yellow.

Measurements.—

Length of head.....	1.48 mm.
Width of head.....	.65- .68 mm.
Length of antennae.....	1.77 mm.
Length of pronotum.....	.42 mm.
Width of pronotum.....	.51 mm.
Length of hind tibia.....	1.06 mm.

Comparison with other species.—Easily distinguished from all other de-

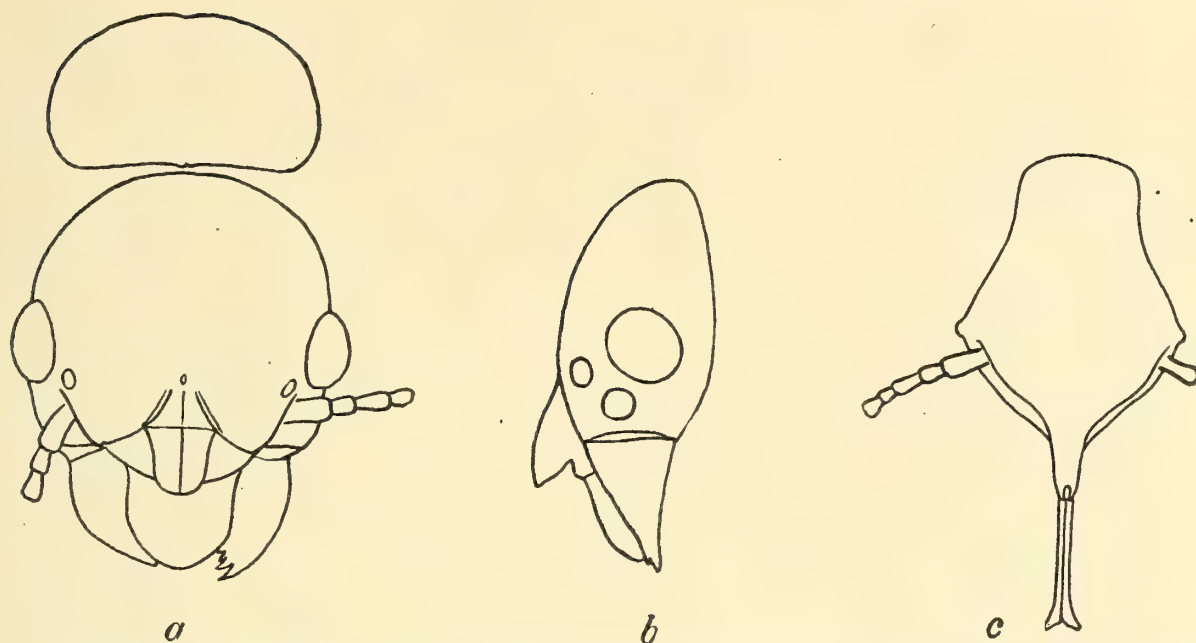


Fig. 43. *Rhinotermes (Rhinotermes) subfusciceps*; sp. nov. *a*, imago, dorsal view of head and pronotum; *b*, imago, lateral view of head; *c*, minor soldier, dorsal view of head.

scribed minor soldiers of *Rhinotermes* by the color of the head and the constriction in the head.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Queen.

Morphotype.—Minor soldier.

Described from a single queen and many minor soldiers collected by the author at Kartabo from two different colonies. In both cases each colony was thoroughly searched for major soldiers but for some unaccountable reason no specimens of this caste seemed to be present.

Family TERMITIDAE Light

Although Holmgren (1910b) tentatively divided this family (= *Metatermitidae*) into several subfamilies, he later (1912) did not recognize them, but instead divided the whole family into groups of genera. The family as a whole needs further study before well defined subfamilies can be distinguished.

This is by far the largest of the four known families of termites, approximately 75 per cent. of the known species belonging to the Termitidae. It has not been able to spread as far north as the Rhinotermitidae, but is found in all the tropical and subtropical parts of the globe. Banks (Banks & Snyder 1920) combined this family with the Rhinotermitidae into a single family but I feel that the characteristics of the two groups warrant Holmgren's division into families.

Genus *Syntermes* Holmgren

Including the species described in this report, this genus now includes thirteen species, all confined to South America. Of these, three species were found at Kartabo, two of which are new. *S. grandis* (Rambur) has also been reported from British Guiana but was not found by the author.

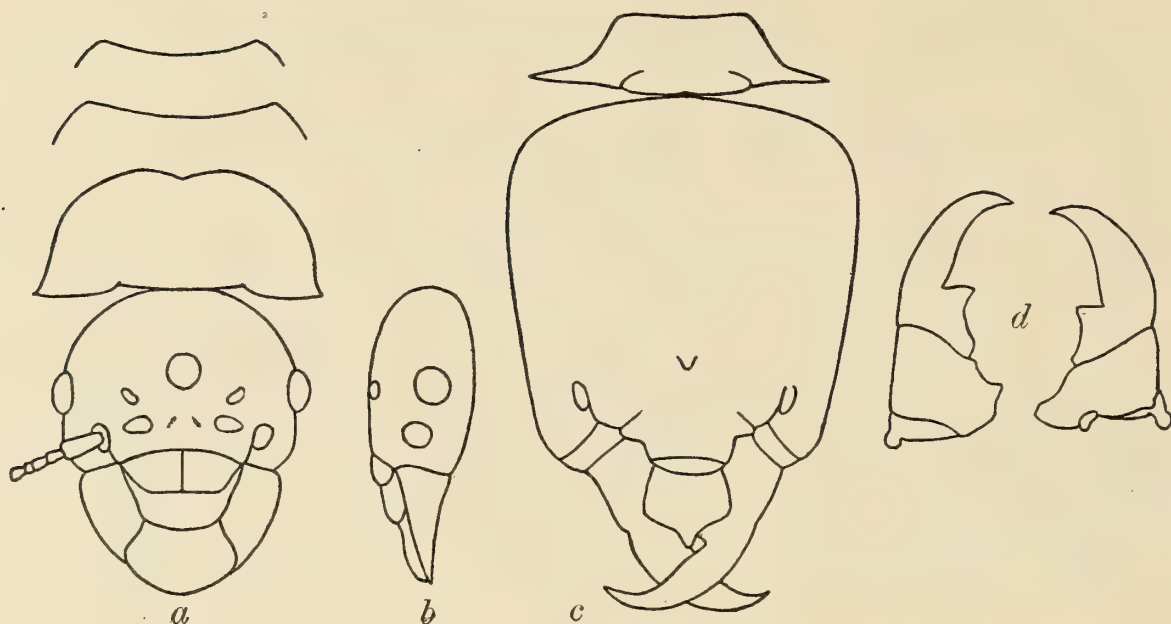


Fig. 44. *Syntermes snyderi*, sp. nov. *a*, imago, dorsal view of head, pronotum and margins of thoracic nota; *b*, imago, lateral view of head; *c*, soldier, dorsal view of head and pronotum; *d*, soldier, mandibles.

***Syntermes snyderi*, sp. nov.**

(Fig. 44)

Imago.—Head orange yellow, clothed with a few short bristles; oval and proportionately thin; fontanelle large and round, its diameter much longer than the ocelli; muscle insertions in front of the ocelli.

Antennae with 19–20 segments. Eyes small, about $\frac{3}{5}$ their own diameter from the lower margin.

Ocelli proportionately small, twice their own length from the eyes.

Posterior clypeus with a faint median line.

Pronotum a little lighter than the head; conspicuously wider than the head; anterior angles sharply pointed; posterior margin emarginate, anterior margin slightly emarginate; margins clothed with short bristles.

Meso- and metanota lighter than the pronotum, yellowish; posterior margins widely concave. Wings dark smoky.

Abdominal tergites dark brown; nearly smooth, with only a few short marginal bristles.

Measurements.—

Length with wings	35.00–40.00 mm.
Length without wings	17.00–21.00 mm.
Length of head	4.77– 4.85 mm.
Width of head	3.84– 3.86 mm.
Length of antennae	5.90 mm.
Diameter of eye . . . . .	.71 mm.
Length of pronotum	2.01 mm.
Width of pronotum	4.37 mm.

Measurements.—

Length of hind tibia.....	7.09 mm.
Length of anterior wing.....	30.50 mm.
Width of anterior wing.....	7.80 mm.

Remarks.—The angles of the pronotum do not project as far as they do in Hagen's figure of *S. dirus*.

Soldier.—Head brownish to orange yellow, front a little darker; thickly covered with short bristles; widest behind, sides straight.

Antennae darker than the head, with 19 segments.

Labrum with a 3-lobed hyaline point.

Mandibles black, strong, with a large tooth on each mandible (see fig.).

A small frontal tube is present in the middle of the head.

Thoracic nota with long, strong, cylindrical pointed spines, the spine of the pronotum extending out straight and those on meso- and metanota pointed somewhat backward. Pronotum with many short bristles; same color as the head; anterior lobe very slightly emarginate.

Measurements.—

Total length.....	22.00 mm.
Length of head.....	9.10– 9.20 mm.
Width of head.....	6.74– 6.85 mm.
Length of antennae.....	8.19 mm.
Width of pronotum.....	5.79 mm.
Length of hind tibia.....	6.74 mm.
Length of left mandible.....	4.14 mm.

Remarks.—This soldier seems to be larger than the measurements of *S. dirus* given by Holmgren (1911a) in his key. Hagen (1858) states that the length of the soldier of *S. dirus* is 19.00 mm. I believed at first that this termite was *S. dirus*, but Dr. T. E. Snyder compared it with a type at the Mus. Comp. Zool., and states that the teeth on the mandibles differ and *S. snyderi* is larger.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Soldier.

Morphotype.—Imago.

Described from two winged imagos and many soldiers collected by the author from four different colonies at Kartabo. The species is named in honor of Dr. T. E. Snyder. It is probable that the specimens from British Guiana referred to *S. dirus* by Walker (1853) and Hagen (1858a) belong to this species.

Syntermes territorius, sp. nov.

(Fig. 45)

Imago.—Head dark brown, oval, proportionately thin; clothed with only a few bristles; four muscle insertions in a row in front of the ocelli. Fontanelle subcircular, about the same length as the ocelli.

Antennae yellow brown with 19–20 segments, the 3d sometimes showing signs of dividing.

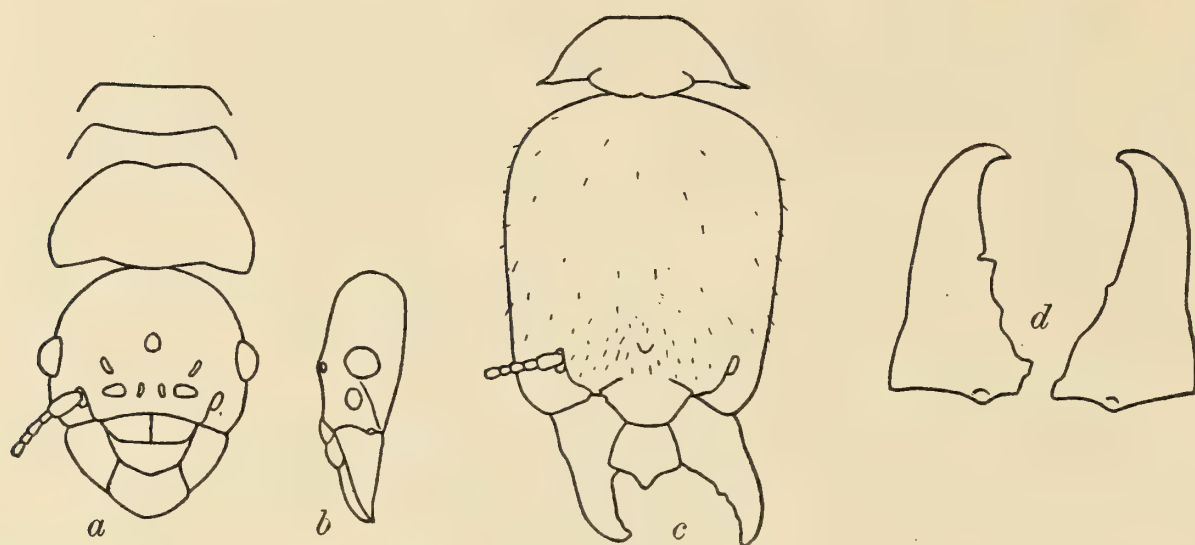


Fig. 45. *Syntermes territus*, sp. nov. *a*, imago, dorsal view of head, pronotum and margins of thoracic nota; *b*, imago, lateral view of head; *c*, soldier, dorsal view of head and pronotum; *d*, soldier, mandibles.

Eyes small, about $\frac{1}{2}$ their diameter (.29 mm.) from the lower margin of the head.

Ocelli of medium size, nearly twice their length from the eyes. Labrum yellow brown. Posterior clypeus yellow brown with a median line.

Pronotum dark brown, about the same width or slightly narrower than the head; margins hairy. The anterior region of the pronotum somewhat elevated; anterior margin slightly emarginate; anterior angles forming right angles; posterior margin conspicuously emarginate.

Posterior margins of meso- and metanota straight or slightly concave.

Wings dark brown, smoky; veins distinct throughout.

Abdominal tergites dark brown, with short bristles.

Measurements.—

Length with wings.....	32.00–34.00 mm.
Length without wings.....	18.00 mm.
Length of head.....	3.75– 3.78 mm.
Width of head.....	3.24 mm.
Length of antennae.....	5.00 mm.
Diameter of eye.....	.58 mm.
Length of pronotum.....	1.54 mm.
Width of pronotum.....	3.19 mm.
Length of hind tibia.....	4.49 mm.
Length of anterior wing.....	24.50 mm.
Width of anterior wing.....	6.00 mm.

Comparison with other species.—Seems to differ from the descriptions of *S. grandis* in that the wings are not white and transparent. Also Hagen's (1858) measurements are a little smaller.

Soldier.—Head brownish orange yellow, front somewhat darker; sub-rectangular, the sides nearly parallel; sparsely covered with short bristles, conspicuously fewer than on *S. dirus*.

Antennae with 19 segments. Labrum brownish yellow with a 3-lobed hyaline tip.

Mandibles black; left with short teeth, an incision in front of the 1st tooth; 2d tooth very blunt and small; right mandible with a nearly smooth inner edge.

A very small tube is present in the middle of the forehead.

Thoracal nota slightly darker than the head, each with a pair of conspicuous sharp spines on the sides, these being relatively short and small, compared to the spines of *S. dirus*. Pronotum with a few short bristles, anterior portion raised, margin slightly emarginate. Abdominal tergites with a row of bristles on the margins.

Measurements.—

Total length.....	16.00–17.00 mm.
Length of head.....	8.27 mm.
Width of head.....	4.75– 4.96 mm.
Length of antennae.....	5.32 mm.
Width of pronotum.....	3.55– 3.63 mm.
Length of hind tibia.....	4.37 mm.
Length of left mandible.....	3.19 mm.

Comparison with other species.—Differs from *S. grandis* in the sides of the head being nearly parallel. The mandibles are more curved than in *S. silvestrii* and the right mandible has a nearly smooth inner margin. *S. territus* must be close to *S. bolivianus* but Holmgren's (1911a) description is too meagre to be sure of the relationship of these species.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Soldier.

Morphotype.—Winged imago.

Described from numerous specimens collected by the author at Kartabo from five different colonies.

Syntermes parallelus Silvestri.

Syntermes parallelus Silvestri (1923), p. 318 (imago, soldier, major worker minor worker), pl. XV (imago, soldier, worker).

(Fig. 46)

Imago.—Head dark brown, oval. Fontanelle lighter than head, larger than ocelli. Four muscle insertions in a line in front of the ocelli.

Antennae with 19 segments, the 2d a little smaller than the 3d and much longer than the 4th (Silvestri).

Eyes proportionately small, a little less than $\frac{1}{2}$ their width from the lower margin. Ocelli proportionately small, twice their length removed from the eyes.

Postclypeus a little lighter than the head; with median line.

Pronotum lighter and nearly as wide as the head; anterior angles rather sharp, posterior margin emarginate.

Posterior margins of the meso- and metanota widely concave.

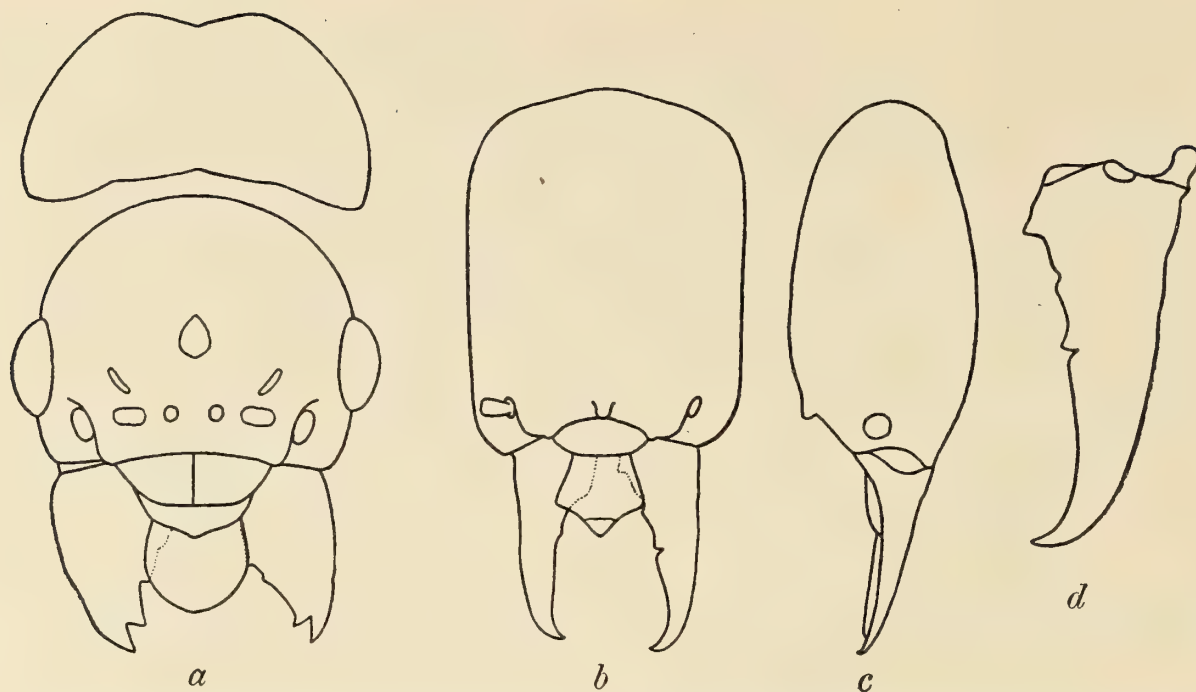


Fig. 46. *Syntermes parallelus* Silvestri. a, imago, dorsal view of head and pronotum; b, soldier, dorsal view of head; c, soldier, lateral view of head; d, soldier, left mandible.

Wings smoky, membrane covered with small hairs.

Abdominal tergites almost as dark as the head.

Measurements.—

Length with wings	29.00 mm. (Silv.)
Length without wings	17.00 mm. (Silv.)
Length of head	3.67 mm.
Width of head	3.15 mm.
Length of antennae	5.00 mm. (Silv.)
Diameter of eye . . . . .	.57 mm.
Length of ocellus . . . . .	.27 mm.
Length of pronotum	1.17 mm.
Width of pronotum	2.93 mm.
Length of hind tibia	4.00 mm. (Silv.)
Length of anterior wing	24.50 mm. (Silv.)
Width of anterior wing	5.80 mm. (Silv.)

Soldier.—Head brownish yellow, covered with short hairs; sides straight and almost parallel. A short frontal tube in the middle of the forehead.

Antennae with 19 segments (Silvestri).

Mandibles black. Left with an indentation about $\frac{1}{2}$ the length of the mandibles and several rounded teeth at the base. Right with a small obtuse tooth about $\frac{2}{5}$ the length of the mandible from the base.

Thoracic nota with a rather short spine on each lateral margin.

Measurements.—

Total length	12.00 mm. (Silv.)
Length of head	6.34– 6.80 mm.

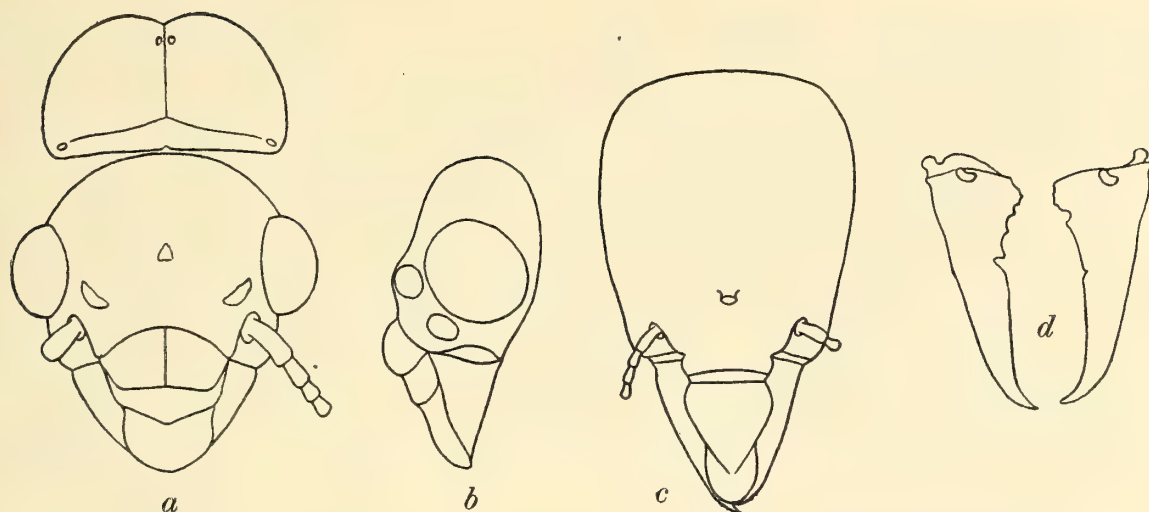


Fig. 47. *Cornitermes (Labiatermes) labralis* Holmgren. *a*, imago, dorsal view of head and pronotum; *b*, imago, lateral view of head; *c*, soldier, dorsal view of head; *d*, soldier, mandibles.

Measurements.—

Width of head.....	2.97– 3.15 mm.
Length of antennae.....	4.60 mm. (Silv.)
Length of hind tibia.....	3.00 mm. (Silv.)
Length of left mandible.....	2.45 mm.

Type locality.—Canister Falls (Demerara River), British Guiana.

New locality.—Kartabo, British Guiana.

Range.—British Guiana.

The description is based upon several soldiers and three imagos found in the stomach contents of *Bufo typhonius* at Kartabo. The specimens were not in good condition and therefore a number of measurements and some of the description is taken from Silvestri's (1923) original description.

Genus *Cornitermes* Wasmann

Holmgren (1912) divided this genus into two subgenera, both of which have representatives in British Guiana.

Subgenus *Labiatermes* Holmgren

There are six known species belonging to this subgenus, two of which are reported from the Belgian Congo, and the other four species are Neotropical. A single species was found at Kartabo, which I refer to *C. labralis* Holmgren described from specimens collected in Peru.

Cornitermes (Labiatermes) labralis Holmgren.

Cornitermes labralis Holmgren (1906), p. 553 (imago, soldier, worker), text-fig. N (imago), text-fig. O (soldier), text-fig. P (worker); (1909), p. 80 (anatomy), fig. 15 (imago).
Cornitermes (Labiatermes) labralis Holmgren (1912), pp. 50, 51, text-fig. 22 (soldier mandibles).

(Fig. 47)

Imago.—Head dark brown, oval, clothed with a few bristles. Fontanelle white, conspicuous, triangular.

Antennae with 17 segments (perfect in both the king and queen), the 2d much larger than the 3d, the 3d slightly larger than the 4th.

Eyes very large, prominent, and very close to the lower margin of the head.

Ocelli large (.94 mm. long), .24 mm. from the eyes.

Posterior clypeus yellowish brown with a faint median line.

Pronotum same color as the head; front margin straight; sides and posterior angles rounded; hind margin emarginate; clothed with many bristles. Posterior margins of the meso- and metanota widely emarginate.

Wings light yellow brown; costal border and radius dark brown at base and yellow near the tip.

Abdominal tergites brown; sternites yellow.

Measurements.—

Length with wings	20.00–21.00 mm.
Length without wings	10.00–11.00 mm.
Length of head	2.01– 2.13 mm.
Width of head	1.90– 1.96 mm.
Length of antennae	2.80– 3.05 mm.
Diameter of eye . . . . .	.73– .77 mm.
Length of pronotum . . . . .	.90– .96 mm.
Width of pronotum	1.56– 1.61 mm.
Length of hind tibia	2.73– 2.89 mm.
Length of anterior wing	16.00–16.80 mm.
Width of anterior wing	4.90– 5.25 mm.
Length of queen	27.00 mm.
Width of abdomen of queen	8.50 mm.
Length of king	8.50 mm.

Remarks.—Holmgren (1906) states that the head of the imago of *C. labralis* is without hair and smooth, but a few bristles on the head were found on specimens from Trinidad.

Soldier.—Head yellow, narrowed in front, sides and posterior margin rounded; a very few short bristles scattered over the head.

Antennae with 15 segments, the 2d equal to the 3d, the 4th shorter than the 3d.

Labrum elongated, subtriangular; tip hyaline, rounded at the end.

Mandibles dark brown, curved only slightly at the tip. Left mandible with an indentation about the middle and a 2d larger indentation near the base. Right mandible with an indentation about the middle and between this and the base are four small blunt teeth.

Short frontal tube with a white tip present in the middle of the forehead.

Pronotum with large bilobed anterior lip, anterior margin conspicuously emarginate, posterior margin evenly curved. Pronotum about the same color as the head. Legs pale.

Abdomen the color of the contents of the intestines.

Measurements.—

Total length	8.86 mm.
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Measurements.—

Length of head.....	4.02 mm.
Width of head.....	2.24–2.36 mm.
Length of antennae.....	2.41 mm.
Length of frontal tube.....	.16–.19 mm.
Length of pronotum.....	.87 mm.
Width of pronotum.....	1.22–1.25 mm.
Length of hind tibia.....	2.25 mm.
Length of left mandible.....	1.67 mm.

Comparison with other species.—*C. longilabius* Silvestri is smaller. The dentation of the mandibles of *C. orthocephalus* Silvestri and *C. laticephalus* Silvestri is entirely different.

Type locality.—Chaquimayo, Peru.

New localities.—Kartabo, British Guiana; St. Joseph, Trinidad, W. I.

Range.—Trinidad, British Guiana, Peru.

The description is based upon the king, queen, and soldiers from a colony collected by the author in Trinidad and upon a queen, winged imagos and soldiers collected from two colonies by the author at Kartabo.

Subgenus *Cornitermes*, s. str. Holmgren

This subgenus formerly included eight species. The single species collected in British Guiana seems to be new, thus making nine known species belonging to the subgenus, all of which are found only in the Neotropical region.

Cornitermes (Cornitermes) pugnax, sp. nov.

(Fig. 48)

Imago.—Head dark brown, widely egg-shaped; clothed with a few long bristles; fontanelle large, oval and dark, longer than the ocelli. Two large muscle insertions in front of the ocelli.

Antennae with 15 segments, the 3d sometimes showing signs of division.

Eyes large and prominent. Ocelli large, distinctly more than their own length removed from the eyes. Labrum yellow brown.

Posterior clypeus dark brown, no median line visible.

Pronotum dark brown, a T-shaped series of light streaks in the middle; middle with few hairs but the margins with many; sides straight, converging strongly toward the rear; posterior margin somewhat emarginate. Wings dark smoky.

Posterior margins of the meso- and metanota widely emarginate; angles of the mesonotum sharp. Abdominal tergites and sternites dark brown.

Measurements.—

	Male	Female
Length with wings.....	16.40 mm.	19.00 mm.
Length without wings.....	9.50 mm.	11.00 mm.
Length of head.....	2.02 mm.	2.57 mm.
Width of head.....	1.99 mm.	2.31 mm.
Diameter of eye.....	.38 mm.	.55 mm.

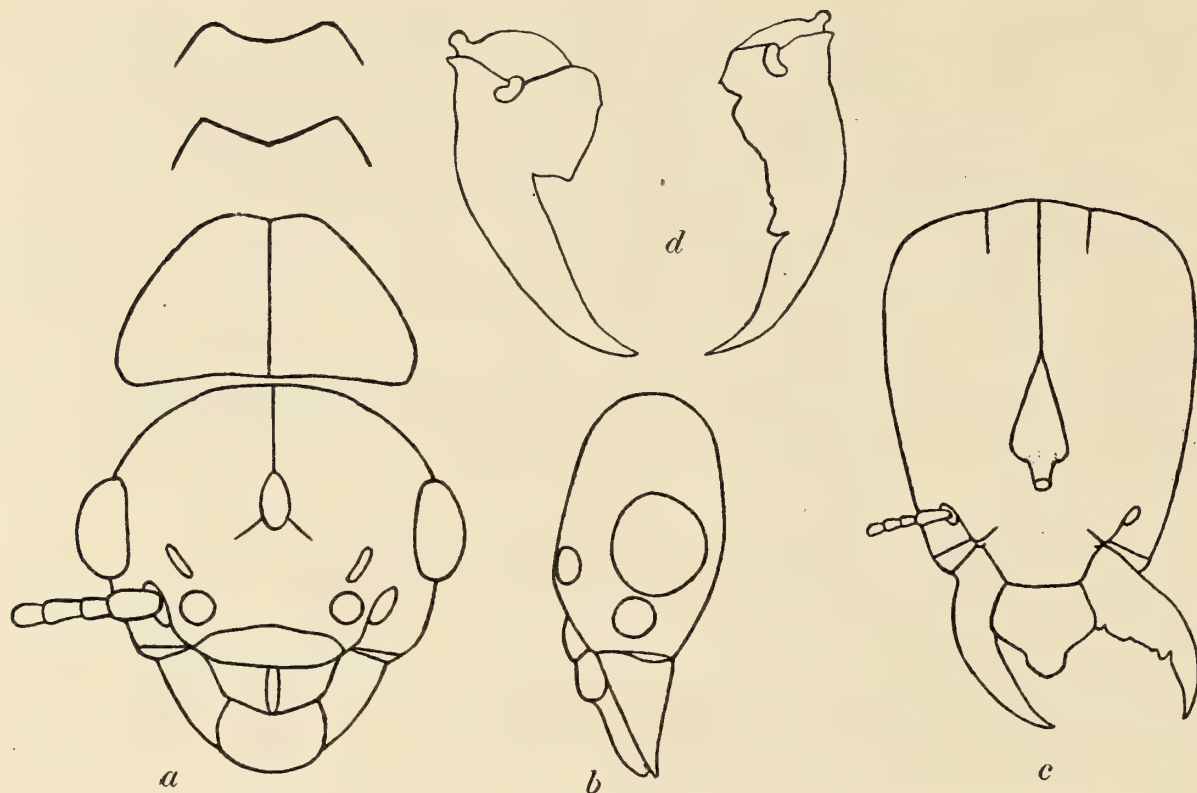


Fig. 48. *Cornitermes* (*Cornitermes*) *pugnax*, sp. nov. a, imago, dorsal view of head, pronotum and margins of thoracic nota; b, imago, lateral view of head; c, soldier, dorsal view of head; d, soldier, mandibles.

Measurements.—

Length of pronotum.....	.80 mm.	.96 mm.
Width of pronotum.....	1.67 mm.	1.83 mm.
Length of hind tibia.....	1.54 mm.	2.18 mm.
Length of anterior wing.....	13.35 mm.	14.60 mm.
Width of anterior wing.....	3.75 mm.	4.00 mm.
Length of queen.....		38.00 mm.
Width of abdomen of queen.....		7.00 mm.

Comparison with other species.—*C. similis* (Hagen) Silv. is lighter in color and the fontanelle is white.

Soldier.—Head yellow, subrectangular, widest toward the rear, narrowed somewhat in front; clothed with numerous medium long bristles.

Antennae yellow, with 15 segments. Labrum yellow, pentagonal or rounded in general shape, tip hyaline.

Mandibles large and powerful. Right mandible with one large tooth behind the middle and another small tooth near the base. Left mandible with rather coarse serrations.

Frontal tube at least .29 mm. long, upturned and fringed on the end with hairs.

Pronotum yellow, bristles only on the margins; anterior margin slightly emarginate. Legs pale.

Abdomen pale, tergites with many bristles.

Measurements.—

Total length.....	8.00–9.00 mm.
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Measurements.—

Length of head	4.30–4.40 mm.
Width of head	2.67–2.78 mm.
Length of antennae	2.57–2.65 mm.
Width of pronotum	1.28–1.38 mm.
Length of hind tibia	2.09–2.14 mm.
Length of left mandible	1.73 mm.

Comparison with other species.—Closest to *C. acignathus* Silvestri in size and shape of head, but it seems to differ in the dentation of the mandibles as figured by Silvestri (1903). It is possible, however, that this is the same species. Banks (1918) records *C. acignathus* from British Guiana and my specimens agree with his.

Type locality.—Kartabo, British Guiana.

Other localities.—Dunoon, British Guiana.

Holotype.—Soldier.

Morphotype.—Winged imago.

Described from numerous winged imagos, four reproductive forms and numerous soldiers collected by the author from six different colonies at Kartabo and several soldiers collected by F. M. Gaige from a single colony at Dunoon.

Genus *Armitermes* Wasmann

Holmgren (1912) divided this genus into three subgenera. *It contains ten species distributed as follows: *Armitermes*, s. str. (seven), *Curvitermes* (two), *Rhynchotermes* (one). All subgenera are known only from the Neotropical region. Only one subgenus, *Armitermes*, s. str. has been found in British Guiana. Four new species described in this report bring the total number of species known in the genus to fourteen.

Subgenus *Armitermes*, s. str. Holmgren

Five species belonging to this subgenus were found in British Guiana, of which four proved to be new.

Armitermes (Armitermes) albidus (Hagen).

Termes albidus Hagen (1858), p. 225 (imago, soldier), pl. 3, fig. 34 (imago).

Termes albidus Hagen (1858a), p. 32 (imago).

(?) *Armitermes albidus* Silvestri (1901), p. 7.

(?) *Armitermes albidus* Silvestri (1903), p. 79 (imago, soldier, worker), p. 131 (biology), pl. 3, fig. 40 (soldier).

Armitermes euamignathus Silvestri (1901), p. 6 (imago); (1903), p. 76 (imago, soldier, worker), p. 129 (biol.), text-fig. 19 (wings), text-fig. 46 (nest), pl. 3, fig. 133 (imago), fig. 134 (soldier), figs. 135–137 (2d form, king and queen).

(Fig. 49)

Imago.—Head brownish black, oval; clothed with numerous long hairs. Fontanelle very small and inconspicuous.

Antennae with 15 segments, the 3d slightly shorter than the 2d, the 4th about the same length as the 3d.

Eyes of medium size, .064 mm. from the lower margin of the head.

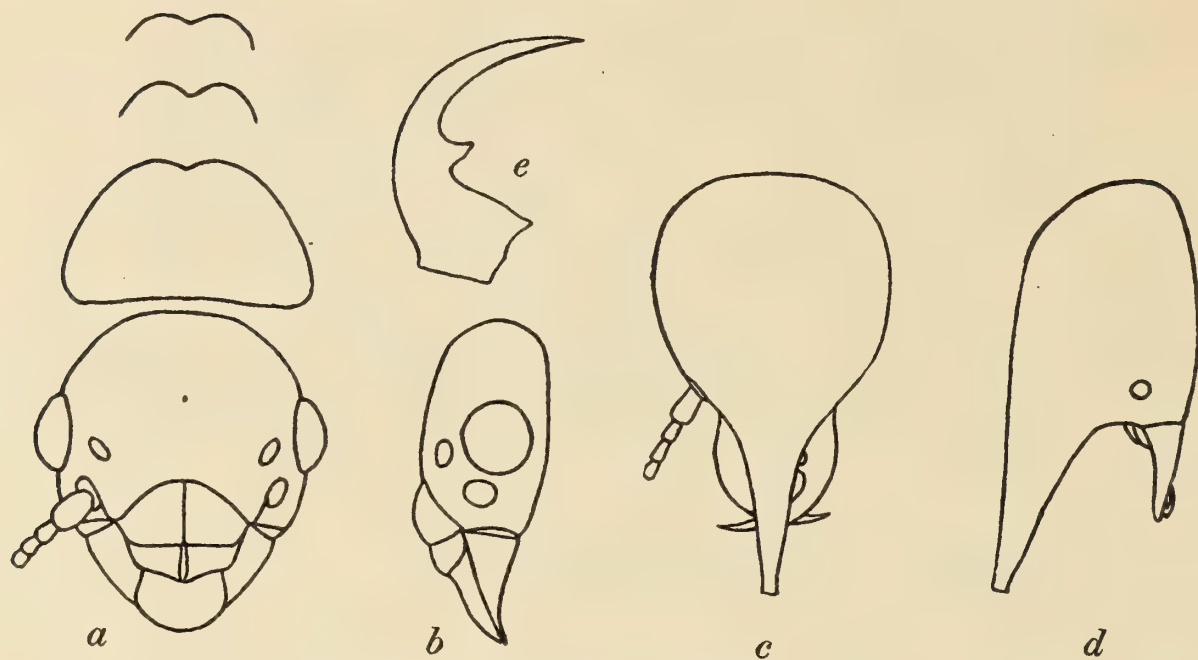


Fig. 49. *Armitermes (Armitermes) albidus* (Hagen). *a*, imago, dorsal view of head, pronotum and margins of thoracic nota; *b*, imago, lateral view of head; *c*, soldier dorsal view of head; *d*, soldier, lateral view of head; *e*, soldier, left mandible.

Ocelli oval, prominent, less than their diameter removed from the eyes. Labrum lighter than the head. Posterior clypeus brownish black, faint median line visible.

Pronotum brownish black; clothed with numerous long hairs. Pronotum not quite as wide as the head, sides fairly straight, posterior margin emarginate and angles rounded.

Posterior margins of the meso- and metanota emarginate, angles rounded, sides with a white band reaching nearly to the posterior margin. Wings dark smoky.

Abdominal tergites a little lighter than the pronotum.

Measurements.—

Length with wings.....	12.00–12.50 mm.
Length without wings.....	5.00– 6.50 mm.
Length of head.....	1.35 mm.
Width of head.....	1.16– 1.19 mm.
Length of antennae.....	1.77– 1.80 mm.
Diameter of eye.....	.35 mm.
Length of pronotum.....	.61 mm.
Width of pronotum.....	1.00 mm.
Length of hind tibia.....	1.64 mm.
Length of anterior wing.....	9.10 mm.
Width of anterior wing.....	2.57 mm.
Length of queen.....	23.50 mm.
Width of abdomen of queen.....	6.00 mm.
Length of king.....	5.00 mm.

Soldier.—Head brownish yellow, clothed with a few long hairs.

Antennae with 13–14 segments. Mandibles red brown, strongly curved,

a conspicuous tooth in the middle of each mandible. The tooth of the left mandible obliquely truncated, larger than the tooth of the right mandible.

Nose stout, usually somewhat turned up at the end.
Pronotum with marginal bristles and shorter hairs, anterior margin about the same color as the head. Legs pale.
Abdomen the color of the contents of the intestine; tergites covered with long hairs and a row of bristles on the posterior margins.

Measurements.—

Total length	4.00–7.00 mm.
Length of head	1.80–1.95 mm.
Width of head	1.00–1.07 mm.
Length of antennae	1.50–1.60 mm.
Length of pronotum	.32 mm.
Width of pronotum	.61–.64 mm.
Length of hind tibia	1.00–1.07 mm.
Length of left mandible	.64 mm.

Remarks.—This species does not agree very well with Silvestri’s descriptions and figure, but agrees with Hagen’s types in the Museum of Comparative Zoology, Cambridge, Mass., and also agrees with Hagen’s description. Specimens of *A. euamignathus* Silvestri, determined by Silvestri from Asuncion, Paraguay, agree perfectly in both imago and soldier characters with the Kartabo specimens.

Type locality.—Santarem, Brazil.
New localities.—Kartabo, British Guiana; Port of Spain, Trinidad.
Range.—Brazil, British Guiana, Trinidad, Paraguay, Matto Grosso.

The description is based upon many specimens of all castes collected by the author from nine different colonies at Kartabo. Several soldiers and workers collected by the author from a single colony in Trinidad also agree with the Kartabo specimens.

Armitermes (Armitermes) percutiens, sp. nov.
(Fig. 50)

Imago.—Head light brown, light dots at the base of every hair, giving a speckled appearance, region around the base of the antennae yellow; widely oval; clothed with long hairs. Fontanelle small, inconspicuous.
Antennae pale, with 15 segments.
Eyes large, prominent, close to the lower margin of the head. Ocelli fairly large, less than their diameter from the eyes.
Labrum yellow. Postclypeus yellow with median line.
Pronotum yellow, lighter than the head; hind margin emarginate, sides rounded.
Wings hyaline, covered with short hairs.

Measurements.—

Length with wings	12.00–13.00 mm.
Length without wings	6.50–7.50 mm.

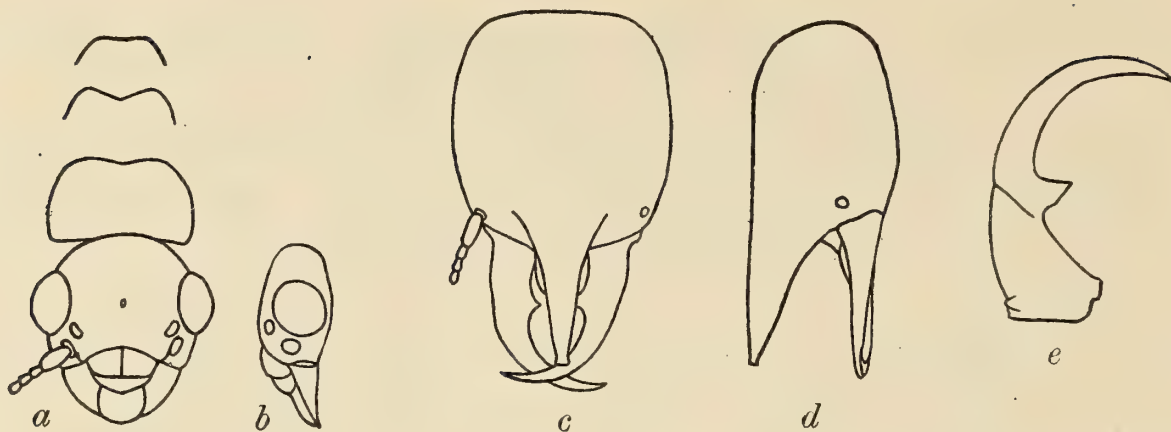


Fig. 50. *Armitermes (Armitermes) percutiens*, sp. nov. *a*, imago, dorsal view of head, pronotum and margins of thoracic nota; *b*, imago, lateral view of head; *c*, soldier, dorsal view of head; *d*, soldier, lateral view of head; *e*, soldier, left mandible.

Measurements.—

Length of head	1.18– 1.22 mm.
Width of head	1.12– 1.18 mm.
Length of antennae	1.85– 1.93 mm.
Diameter of eye	.42 mm.
Length of pronotum	.55 mm.
Width of pronotum	.96– 1.00 mm.
Length of hind tibia	1.51 mm.
Length of anterior wing	10.40 mm.
Width of anterior wing	2.78 mm.

Comparison with other species.—Very close to *A. neotenicus* Holmgren, but seems to differ in the fontanelle not being triangular. The eyes also seem to be a little larger than in Holmgren's figure.

Soldier.—Head yellow, somewhat rectangular, sides a little rounded, profile straight or slightly convex; clothed with a few bristles.

Antennae pale, 14-segmented, the 2d shorter than the 3d, the 4th shorter than the 2d.

Mandibles longer than the nose, strongly curved; base yellowish, tips dark. The left mandible with a conspicuous, pointed, triangular tooth, usually with a tendency toward being truncate, and another obtuse tooth near the base; inner edge between the tip and 1st tooth with microscopical serrations. Right mandible with a conspicuous tooth in the middle.

Pronotum pale, front margin emarginate. Legs pale.

Abdominal tergites hairy. Abdomen the color of the intestinal contents.

Measurements.—

Total length	5.00–6.50 mm.
Length of head	2.18–2.25 mm.
Width of head	1.28 mm.
Length of antennae	1.93 mm.
Length of pronotum	.40– .42 mm.
Width of pronotum	.75– .77 mm.
Length of hind tibia	1.12 mm.
Length of left mandible	1.09 mm.

Comparison with other species.—Differs from *A. neotenicus* in the mandible being a little more curved and the profile straighter. *Specimens of soldiers from the Putymayo, Peru collected by Dr. J. C. Bradley, which I am tentatively referring to *A. neotenicus*, are a little larger than *A. percutiens* and the tooth of the left mandible does not have so much of a tendency to be truncate.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Winged imago.

Morphotype.—Soldier.

The description is based upon many specimens of winged imagos and soldiers collected at Kartabo by the author from ten different colonies. Only one queen of the first form was found in these colonies but many kings and queens of the second form were found.

***Armitermes (Armitermes) teevani*, sp. nov.**

(Fig. 51)

Imago.—Head dark brown, oval, covered with a few bristles.

Antennae with 16 segments, the 2d, 3d and 4th about equal.

Eyes large, prominent and close to the lower margin of the head. Ocelli large, oval, .26 mm. long, about $\frac{1}{4}$ their length from the eyes.

Labrum yellow brown. Posterior clypeus yellow brown with no median line. Fontanelle conspicuous, smaller than ocelli.

Pronotum brown, lighter than the head; a series of Y-shaped light dots in the middle ending near the posterior border in two dots on either side of the median line. Sides straight, converging strongly toward the rear; posterior margin only slightly emarginate; angles rounded; front margin straight.

Posterior margins of the meso- and metanota concave; angles of mesonotum rather sharply rounded.

Wings transparent with a yellowish tinge; costal margin and veins brownish; base of wing near the suture brownish; membrane covered with short hairs.

Measurements.—

Length with wings	18.00–19.00 mm.
Length without wings	9.00–10.00 mm.
Length of head	1.93– 2.09 mm.
Width of head	1.86– 1.99 mm.
Length of antennae	2.73 mm.
Diameter of eye . . . . .	.65– .67 mm.
Length of pronotum . . . . .	.80 mm.
Width of pronotum	1.51– 1.64 mm.
Length of hind tibia	2.35 mm.
Length of anterior wing	14.10 mm.
Width of anterior wing	4.00 mm.

Soldier.—Head yellow brown, large, profile nearly straight; clothed with a few hairs.



Fig. 51. *Armitermes (Armitermes) teevani*, sp. nov. *a*, imago, dorsal view of head and pronotum; *b*, imago, lateral view of head; *c*, soldier, left mandible; *d*, soldier, dorsal view of head; *e*, soldier, lateral view of head.

Antennae with 15 segments, the 4th longer than the 3d, the 2d equal to the 4th.

Mandibles dark red brown, strongly curved, a conspicuous large triangular tooth near the middle of each; right and left mandible nearly the same.

Nose very long and large, nearly as long as the rest of the head.

Pronotum with bristles and short hairs, front margin only very slightly emarginate.

Abdomen the color of the intestinal contents; tergites with long hairs and bristles.

Measurements.—

Total length	5.50–7.00 mm.
Length of head	3.12–3.20 mm.
Width of head	1.57–1.64 mm.
Length of antennae	2.73 mm.
Length of pronotum	.43–.51 mm.
Width of pronotum	.96 mm.
Length of hind tibia	1.90 mm.
Length of left mandible	1.35 mm.

Comparison with other species.—The mandibles are more strongly curved than in any other member of this subgenus.

Type locality.—Kartabo, British Guiana.

Other localities.—Onderneeming, British Guiana.

Holotype.—Winged imago.

Morphotype.—Soldier.

The description is based upon several winged imagos and soldiers collected at Kartabo by Mr. John Tee-Van, many soldiers collected at four different colonies at Kartabo by the author and several soldiers collected at Onderneeming from a single colony by Mr. G. E. Bodkin. I take pleasure in naming the species in honor of Mr. John Tee-Van, who collected the only specimens of winged imagos and who helped me in many other ways in my work on termites at Kartabo.

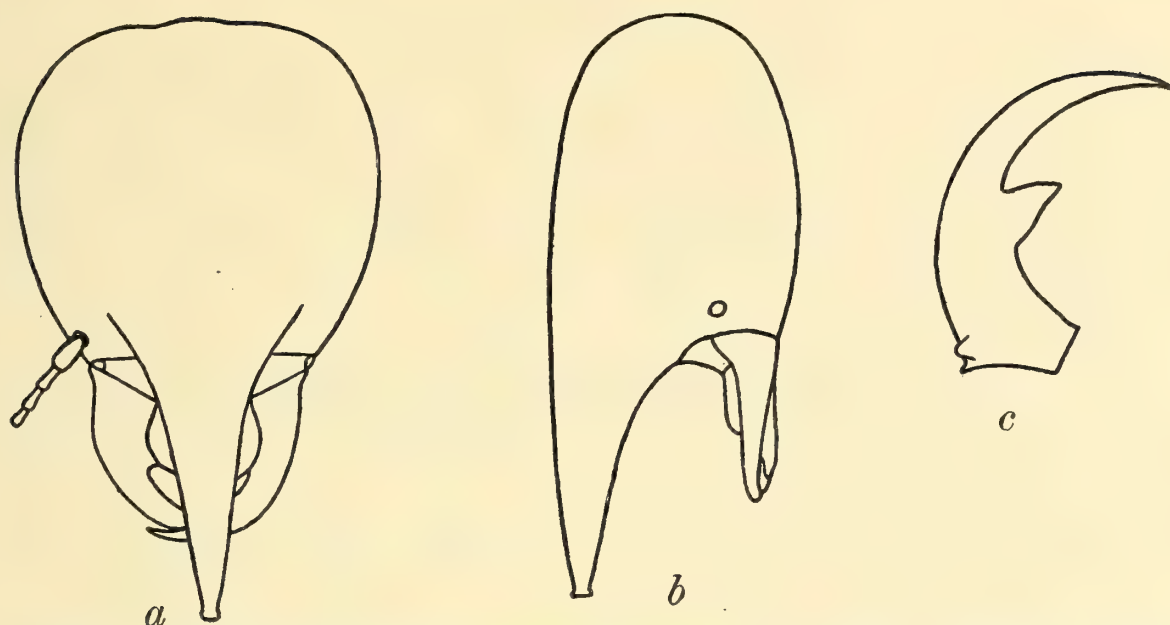


Fig. 52. *Armitermes (Armitermes) grandidens*, sp. nov. a, soldier, dorsal view of head; b, soldier, lateral view of head; c, soldier, left mandible.

***Armitermes (Armitermes) grandidens*, sp. nov.**

(Fig. 52)

Soldier.—Head brownish yellow, roundly oval with a convex profile; usually covered with about 6–10 bristles.

Antennae with 14 segments, the 2d equal to the 3d, the 4th a little shorter than the 3d.

Labrum with a rounded tip. Mandibles dark red brown, strong and curved, about $\frac{2}{3}$ the length of the nose. Left mandible with a large strong triangular tooth in the middle, somewhat pointed up. Right mandible somewhat similar to the left.

Nose long and stout, slightly reddish.

Pronotum with the anterior margin yellow; margins with long bristles.

Abdomen the color of the contents of the intestine; sternites with long hairs.

Measurements.—

Total length	7.50–8.00 mm.
Length of head	3.21–3.37 mm.
Width of head	1.71–1.77 mm.
Length of antennae	2.15–2.25 mm.
Length of pronotum	.53–.57 mm.
Width of pronotum	.96–1.03 mm.
Length of hind tibia	1.54–1.60 mm.
Length of left mandible	1.22 mm.

Comparison with other species.—Closest to *A. peruanus* Holmgren, but smaller. The tooth of the mandible proportionately larger than in Holmgren's figure (1912, p. 57).

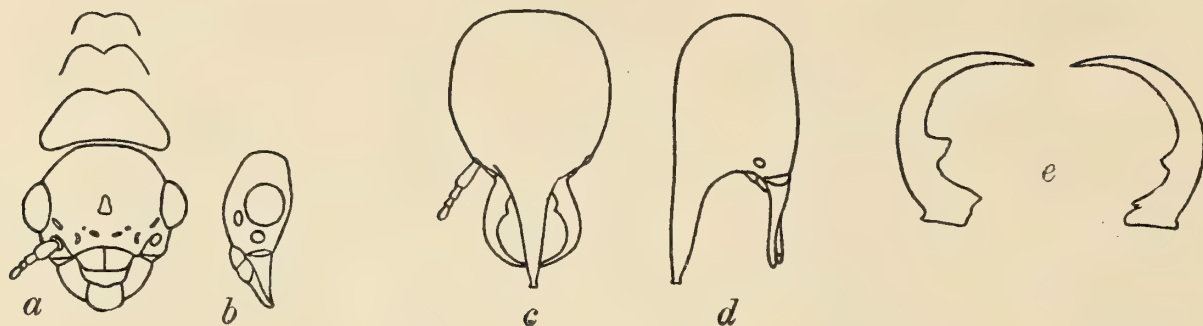


Fig. 53. *Armitermes (Armitermes) minutus*, sp. nov. *a*, imago, dorsal view of head, pronotum and margins of thoracic nota; *b*, imago, lateral view of head; *c*, soldier, dorsal view of head; *d*, soldier, lateral view of head; *e*, soldier, mandibles.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Soldier.

The description is based upon numerous soldiers collected by the author from two different colonies at Kartabo. The nest and reproductive forms were never discovered.

***Armitermes (Armitermes) minutus*, sp. nov.**

(Fig. 53)

Imago (king).—Head brown, oval, somewhat angular behind; covered with a few bristles. Fontanelle dull, large and triangular. Muscle insertions in a curved row in front of the fontanelle.

Antennae pale, with 14 segments, the 3d much smaller than the 2d, the 2d equal to the 4th.

Eyes large, prominent and close to the lower margin of the head. Ocelli of medium size, prominent, less than $\frac{1}{2}$ their diameter from the eyes.

Labrum lighter than the head. Posterior clypeus lighter than the head, long, with median line.

Pronotum brown, narrower than the head; sides straight, angles rounded, posterior margin emarginate.

Posterior margins of the meso- and metanota emarginate, angles rounded. Abdominal tergites brown, hairy.

Measurements.—

Length of head	1.03 mm.
Width of head . . . . .	.94 mm.
Length of antennae	1.30 mm.
Diameter of eye . . . . .	.30 mm.
Length of pronotum . . . . .	.43 mm.
Width of pronotum . . . . .	.77 mm.
Length of hind tibia	1.06 mm.
Length of king	3.40 mm.

Comparison with other species.—Smaller than any other known species of this subgenus.

Soldier.—Head yellow brown, roundly oval with a straight profile; sparsely covered with bristles.

Antennae pale, with 13 segments, the 3d nearly as long as the 2d, the 4th shorter than the 3d.

Mandibles darker than the head, nearly as long as the nose, strongly curved. The left mandible with large tooth obliquely truncated; the inside edge of the mandible between the apex and the tooth with minute serrations pointed backwards. The tooth on the right mandible is triangular.

The nose slightly darker than the head, of medium length and rather large. Pronotum with the anterior margin the same color as the head.

Abdomen the color of the intestinal contents; tergites hairy.

Measurements.—

Total length	3.00–5.50 mm.
Length of head	1.50–1.54 mm.
Width of head	.87 mm.
Length of antennae	1.35 mm.
Length of pronotum	.21 mm.
Width of pronotum	.53 mm.
Length of hind tibia	.75–.83 mm.
Length of left mandible	.71 mm.

Comparison with other species.—Smaller than any other known member of this subgenus.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Soldier.

Morphotype.—King.

The description is based upon a single king and many soldiers collected from seven different colonies at Kartabo by the author. Many 2d form queens and a single 2d form king were also found.

Genus *Nasutitermes* Banks

The name of this genus, long known as *Eutermes*, has recently been changed to *Nasutitermes* by Banks (Banks & Snyder, 1920) because specimens determined by Hagen as *Eutermes debilis* Heer, the type of the genus, have proved to belong to *Microcerotermes*. This change has caused consternation among many workers and my impression is that numerous authorities will not accept the change of names, at least at present. However, Banks is right in saying that the name *Eutermes* should be given to the genus to which *Eutermes debilis* Heer belongs. Banks, however, has not seen the type specimen and I have the impression that Hagen may very likely have been wrong in his determination of *Eutermes debilis* as a West Indian species, now known as a *Microcerotermes*. It is well known how difficult it is, even with our present knowledge of termites, to determine genera accurately from the imago alone, and Hagen knew little of our modern generic divisions and the characters by which they are separated. I expect

that I have no good cause to doubt this determination without seeing the original copal specimen which Hagen states is in the "Zurich Museum," but as this change of generic names involves the change of a great many specific names of species of *Microcerotermes* which have been given the same specific names as species of *Eutermes*, I feel that I have the right not to accept this change of names until the matter has been cleared by the accurate determination of the type specimen.

Thus, in order to avoid the change of so many specific names now and in the future, I have resolved to confine the name *Eutermes* to the original species, to use the name *Nasutitermes* in place of the generally accepted name *Eutermes*, and to leave the name *Microcerotermes* as it is. With this method, the different specific names can remain unchanged at present until *Eutermes debilis* Heer has been carefully examined and compared with modern genera. Neither of the generic names I use in this report should confuse the various workers.

I use the term *Nasutitermes* to include all those forms which possess nasuate soldiers with degenerate mandibles. I have also placed the forms in subgenera using Holmgren's (1912) classification, although I realize that the group as a whole needs to be thoroughly revised with material from all parts of the world, before all these subgenera are well established. Many of them may also be raised to generic rank in the future, but at present I believe it will be less confusing to treat them all as belonging to a single genus.

In the sense in which I use the name, the genus *Nasutitermes* is the dominant genus of the world. It is found in all tropical countries the world over and includes 288 species, over half of which belong to the subgenus *Nasutitermes*, s. str. *Nasutitermes* has been divided into twenty subgenera, five of which were found in British Guiana. One new species differed so much from the known species of the genus that I have placed it in a new subgenus, *Angularitermes*.

Altogether there are nine subgenera reported from the Neotropical region including *Angularitermes*. Of these six are known to occur in British Guiana.

Subgenus *Nasutitermes*, s. str.

This subgenus now contains 154 species including the new forms described in this report. Its distribution is the widest of any of the subgenera of *Nasutitermes*. It is found in all the tropical regions of the world and is distributed as follows: Australia, South Sea Islands and New Guinea twenty-two; Africa, Madagascar and surrounding islands twenty-four; Oriental region thirty-seven; Neotropical region seventy.

Twelve species were found in British Guiana which I am referring to this subgenus, four of which are described as new.

Nasutitermes (*Nasutitermes*) *guayanae* (Holmgren).

Eutermes (*E.*) *guayanae* Holmgren (1910), p. 254 (soldier, worker), text-fig. 36 (soldier).

Nasutitermes guayanae Banks 1918, p. 666 (locality).

(Fig. 54)

Imago.—Head brown to dark brown, widely oval; clothed thickly with short hairs and longer bristles; fontanelle slit-shaped, forked at the anterior end, nearly as long as the ocelli.

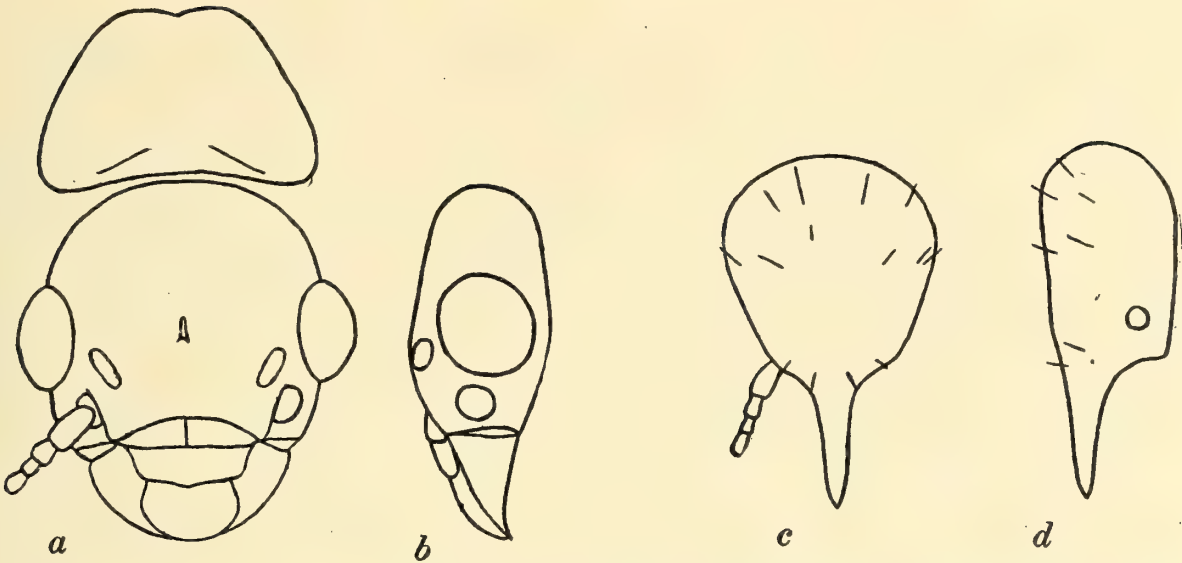


Fig. 54. *Nasutitermes (Nasutitermes) guayanae* (Holmgren). *a*, imago, dorsal view of head and pronotum; *b*, imago, lateral view of head; *c*, soldier, dorsal view of head; *d*, soldier, lateral view of head.

Antennae lighter than the head, with 16 segments, the 3d segment a little narrower than the 2d, the 2d equal to the 4th.

Eyes fairly large and somewhat close to the lower margin of the head. Ocelli of medium size, about $\frac{1}{2}$ their length removed from the eyes.

Labrum lighter than the head. Postclypeus lighter than the head, short, median line visible.

Pronotum same color as the posterior clypeus, not as wide as the head, sides nearly straight, posterior margin emarginate, angles rounded; thickly covered with hair and longer bristles.

Meso- and metanota same color as posterior clypeus; posterior margins emarginate. The angles vary from sharp to round. Abdominal tergites and sternites with long hairs.

Measurements.—

Length with wings.....	17.00 mm.
Length without wings.....	9.00–10.00 mm.
Length of head.....	1.67– 1.77 mm.
Width of head.....	1.51– 1.54 mm.
Length of antennae.....	2.40 mm.
Diameter of eye.....	.48 mm.
Length of pronotum.....	.67– .71 mm.
Width of pronotum.....	1.25– 1.28 mm.
Length of hind tibia.....	1.83 mm.
Length of anterior wing.....	12.76 mm.
Width of anterior wing.....	3.66 mm.
Length of queen.....	26.00 mm.
Length of king.....	7.00 mm.
Width of abdomen of queen.....	7.00 mm.

Comparison with other species.—Specimens of *N. columbicus* (Holmgren) from Panama lent to me by Dr. T. E. Snyder are before me. The imago is shorter in length and the eyes are conspicuously smaller than in *N. guayanae*. It is undoubtedly a distinct species.

Soldier.—Head red brown to dark brown, base of antennae sometimes somewhat lighter; covered with a number of long bristles, 4 at the base of the nose and from 6–12 on the vertex. Head without nose egg-shaped, widest near the posterior part. Profile nearly straight, with an elevation at the base of the nose.

Antennae with 14 segments, the 3d very slightly smaller than the 2d, the 2d and 4th about equal or the 2d is slightly smaller.

Nose fairly large, of medium thickness, the end sometimes lighter than the rest of the head.

Pronotum with a row of minute hairs, longer bristles on the anterior margin; anterior margin dark, not emarginate.

Abdomen somewhat lighter than the head; tergites with a single row of bristles on the posterior margins but entirely lacking short hairs.

Measurements.—

Total length	4.00–5.20 mm.
Length of head	1.73–1.80 mm.
Width of head	1.05–1.15 mm.
Length of antennae	1.54 mm.
Width of pronotum . . . . .	.58 mm.
Length of hind tibia	1.35–1.38 mm.

Remarks.—The nose varies considerably in the proportionate length and the elevation at the base of the nose is more conspicuous in some cases than in others. The variations in color are also rather striking. However, in the large series before me from Kartabo I can find no characters which will distinguish any definite forms.

Comparison with other species.—There seems to be no difference distinguishable between *N. columbicus* and *N. guayanae* soldiers. Holmgren's distinctions do not hold, as specimens of *N. guayanae* agree with his description of *N. columbicus* and also specimens of soldiers from Panama which I refer to *N. columbicus* do not differ in any appreciable way, although the imagos are easily distinguished.

Type locality.—Upper Surinam.

Other localities.—British Guiana: Tukeit, Kaietur, Amatuk, Tumatumari.

New localities.—British Guiana: Kartabo, Dunoon, Upper Cuyuni River, Wenamu River.

The description is based upon several winged imagos, many first form reproductive individuals, and many soldiers collected by the author from thirty-two different colonies at Kartabo. Specimens collected by F. M. Gage from six different colonies at Dunoon, specimens from a single colony collected by Mr. John Tee-Van at Tukeit, and specimens collected by Lavarre from the Upper Cuyuni and Wenamu rivers also agree with the Kartabo specimens.

Nasutitermes (Nasutitermes) costalis (Holmgren).

This species is very variable and has been described under many different names by various authors. I have before me, however, an excellent series of both imagos and soldiers from British Guiana and the West Indies and feel that all doubtless belong to the same species. The specimens from Kartabo alone were found to agree with the various descriptions, and the added knowledge of the imagos makes their identification quite certain.

Banks (Banks and Synder 1920) made *N. morio* (Latr.) the type of the genus *Nasutitermes*. Fabricius (1793), however, had already described a *Termes morio* which is now doubtfully placed in synonymy with *Coptotermes testaceus* (L.). It seems probable that Hagen's *Termes morio* is synonymous with Latreille's. The name of this species, therefore, has to be changed and I have chosen the name *N. costalis* from among the various species described by Holmgren (1910) as the one that has the least doubt concerning its identity. Therefore, *N. costalis* (Holmgren) will be the type species of *Nasutitermes*.

Nasutitermes (Nasutitermes) costalis (Holmgren).

- Termes morio* Latreille (1805), p. 69; (1805a), no. 3.
Termes morio Hagen (1858), p. 200, pl. 3, fig. 29; (1858a), p. 27 (imago); (1860a), p. 122 (imago, soldier).
Termes morio Burmeister (1839), p. 767.
Eutermes costalis Holmgren (1910), p. 293 (imago), text-fig. 64 (imago).
Eutermes Sanctae-Luciae Holmgren (1910), p. 226 (soldier, worker), text-fig. 17 (soldier).
Eutermes martiniquensis Holmgren (1910), p. 238 (soldier, worker), text-fig. 25 (soldier).
Eutermes cayennae Holmgren (1910), p. 232 (soldier, worker), text-fig. 21 (soldier).
Eutermes Cayennae, form *atriceps* Holmgren (1910), p. 234 (soldier), text-fig. 21 (soldier).
Eutermes Cayennae, form *brevinasus* Holmgren (1910), p. 234 (soldier, worker).
Eutermes Cayennae, form *lividus* Holmgren (1910), p. 232 (soldier, worker).
Eutermes Sanchezi Holmgren (1910), p. 236 (soldier), text-fig. 23 (soldier).
Termes (Eutermes) morio Desneux (1915), p. 9 (locality).
Nasutitermes morio Banks (1919), p. 486, 482 (imago, soldier).
Nasutitermes sanchezi Banks (1919), p. 487 (imago), p. 482 (imago, soldier).

(Fig. 55 a, b, c, d)

Eutermes insularis Holmgren (1910) is somewhat larger than any specimens of *Nasutitermes costalis* that I have seen, but I am inclined to believe that it is probably the same species. Banks (Banks & Snyder, 1920) described a species referred to *Nasutitermes costaricensis* from soldiers which coincides with *Nasutitermes costalis*. However, Holmgren (1910) in his key states that the eyes of *N. costaricensis* are larger than those of *N. costalis*.

Imago.—Head dark brown, widely oval. Fontanelle small, forked at the tip. Muscle insertions in a curved row in front of the fontanelle.

Antennae lighter than the head, with 15 segments, the 3d slightly shorter than the 2d, the 3d equal to the 4th.

Eyes small, .14 mm. removed from the lower margin of the head.

Ocelli small, .096 mm. long and .16 mm. removed from the eyes.

Labrum lighter than the head. Postclypeus lighter than the head, median line present.

Pronotum nearly the same color as the head, light streaks in the middle often form T-shaped marks; sides straight, posterior margin not or very slightly emarginate.

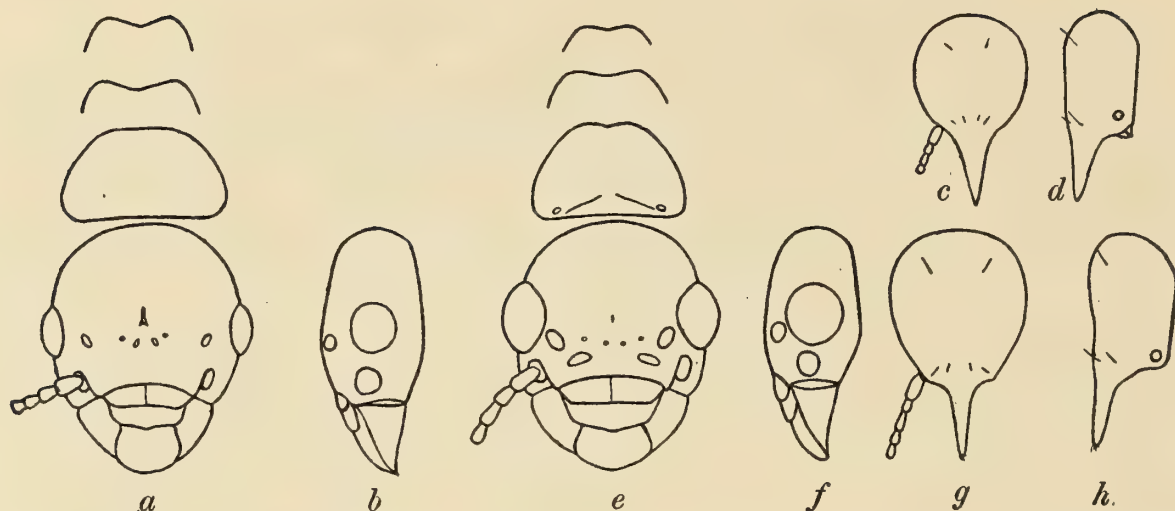


Fig. 55. *Nasutitermes (Nasutitermes) costalis* (Holmgren). *a*, imago, dorsal view of head, pronotum and margins of thoracic nota; *b*, imago, lateral view of head; *c*, soldier, dorsal view of head; *d*, soldier, lateral view of head.

Nasutitermes (Nasutitermes) ephratae (Holmgren). *e*, imago, dorsal view of head, pronotum and margins of thoracic nota; *f*, imago, lateral view of head; *g*, soldier, dorsal view of head; *h*, soldier, lateral view of head.

Posterior margins of meso- and metanota widely emarginate.

Wings dark smoky, usually lighter between the media and cubitus.

Measurements.—

Length with wings.....	14.00–15.00 mm.
Length without wings.....	7.50– 8.50 mm.
Length of head.....	1.54– 1.64 mm.
Width of head.....	1.38– 1.45 mm.
Length of antennae.....	2.25 mm.
Diameter of eye.....	.32– .35 mm.
Length of pronotum.....	.67– .74 mm.
Width of pronotum.....	1.15– 1.28 mm.
Length of hind tibia.....	1.61– 1.64 mm.
Length of anterior wing.....	11.58 mm.
Width of anterior wing.....	3.19 mm.
Length of queen.....	29.50 mm.
Width of abdomen of queen.....	7.00 mm.

Remarks.—Specimens from Dominica and St. Lucia are slightly smaller than those from British Guiana but otherwise no difference can be detected. Specimens from Antigua are usually lighter in color than those from Dominica, St. Lucia, Trinidad and British Guiana.

Soldier.—Head dark reddish brown, lighter around the base of the antennae. Oval in shape, not including the nose, profile with elevation at the base of the nose. Clothed with 6 bristles, 4 at the base of the nose and 2 on the vertex.

Antennae yellowish near the end, with 13 segments, the 3d longer than the 2d, the 2d equal to the 4th.

End of nose lighter than the base; nose rather short and fairly stout at the base.

Pronotum with a brown anterior margin lined with bristles and microscopical hairs.

Abdominal tergites yellowish brown with a single row of bristles on the posterior margins and also covered with microscopical hairs. Hairs on the sternites longer.

Measurements.—

Total length.....	3.50–4.50 mm.
Length of head.....	1.41–1.54 mm.
Width of head.....	.83–1.00 mm.
Length of antennae.....	1.61 mm.
Width of pronotum.....	.50–.53 mm.
Length of hind tibia.....	1.12–1.16 mm.

Remarks.—The nose in some cases is stout and in others medium, the elevation at the base of the nose is conspicuous in some cases and in others nearly absent. Measurements also vary considerably. However, I found some of Holmgren's forms of *E. Cayennae* in the same nest in British Guiana, so I believe that these variations are not definite enough to separate races or forms.

Type locality.—Trinidad.

New localities.—British Guiana: Kartabo, Georgetown; Trinidad: St. Joseph, Port of Spain; St. Lucia: Union, Castries; Martinique: Fort de France; Dominica; Antigua; St. Kitts; Grenada; Dominican Republic: Santiago, Sanchez.

Range.—Brazil, French Guiana, Surinam, British Guiana, Venezuela, Trinidad, Grenada, St. Lucia, Martinique, Dominica, St. Kitts, Monserrat, Antigua, St. Croix, Porto Rico, Hispaniola, Cuba, Jamaica, Guatemala, Panama. (Some of these localities need verification.)

The description is based upon a series from the following localities: Kartabo, British Guiana (many 1st form reproductive individuals and soldiers from sixteen different colonies collected by the author); Georgetown, British Guiana (several first form reproductive individuals and soldiers collected from two different colonies by the author and G. E. Bodkin); St. Joseph, Trinidad (many first form reproductive individuals and soldiers from five different colonies collected by the author); Port of Spain, Trinidad (many soldiers collected from two colonies by the author); Grenada (many first form reproductive individuals and soldiers collected from three different colonies by the author); St. Lucia (several first form reproductive individuals and winged imago collected from five different colonies by Dr. J. C. Bradley and the author); Martinique (numerous soldiers collected from two colonies by Dr. Wm. M. Wheeler and the author); Dominica (several winged imago and soldiers collected from six different colonies by the author); Antigua (several winged imago, kings and queens and soldiers collected from three colonies by the author); St. Kitts (several soldiers collected from four different colonies by the author); Santiago and Sanchez, Dominican Republic (many soldiers collected from two colonies by H. B. Sherman).

Nasutitermes (Nasutitermes) ephratae (Holmgren).

- Eutermes ephratae* Holmgren (1910), p. 223 (imago, worker), *text-fig.* 14 (imago).
Eutermes Klinckowstroemi Holmgren (1910), p. 225 (soldier), *text-fig.* 16 (soldier).

Nasutitermes ephratae Banks (1918), p. 665 (imago, soldier), p. 666 (locality), pl. II, fig. 2 (right) (imago), fig. 11 (soldier).

(Fig. 55, e, f, g, h)

Imago.—Head brown (the mature reproductive forms have lighter heads), widely oval. Fontanelle small, slit-shaped. 4 muscle insertions in a curved row in front of the fontanelle and 2 large ones in front of the ocelli.

Antennae with 15 segments, the 3d longer than the 2d or 4th and shorter than the 1st, the 2d equals the 4th.

Eyes of medium size, oval, .125–.16 mm. from the lower margin of the head. Ocelli rather large and close to the eyes (variation in the distance of the ocelli from the eyes was noticed in imagos from the same colony), in all cases the ocelli are less than their width removed from the eyes.

Labrum brownish yellow. Postclypeus brownish yellow with median line.

Pronotum brownish yellow, rather small; sides somewhat rounded, posterior margin very slightly emarginate.

Posterior margins of the meso- and metanota widely emarginate, angles not very sharp. Legs yellow. Wings light yellow, rather opaque.

Abdominal tergites brownish, nearly the same color as the pronotum.

Measurements.—

Length with wings	12.50–14.50 mm.
Length without wings	7.00– 9.00 mm.
Length of head	1.54– 1.77 mm.
Width of head	1.32– 1.51 mm.
Length of antennae	2.38– 2.57 mm.
Diameter of eye . . . . .	.42– .45 mm.
Length of pronotum . . . . .	.55– .71 mm.
Width of pronotum . . . . .	.96– 1.38 mm.
Length of hind tibia	1.61– 1.67 mm.
Length of anterior wing	10.05–11.58 mm.
Width of anterior wing	2.84– 3.19 mm.
Length of queen	24.00 mm.
Width of abdomen of queen	5.50 mm.
Length of king	8.50 mm.

Comparison with other species.—Can be easily distinguished from *N. costalis* by the larger eye and the ocelli less than their diameter from the eye.

Soldier.—Head rather dark reddish brown, oval without nose; clothed with 4 bristles at the base of the nose and 2 on the vertex; profile with elevation at the base of the nose.

Antennae yellow, a little darker near the base, with 12 or 13 segments. If with 13 segments, the 3d is nearly as long as the 1st and much longer than the 2d or 4th, the 2d equals the 4th. If with 12 segments, the 4th is as long as the 3d, sometimes the 4th showing signs of dividing.

Nose about medium size and thickness, the same color as the rest of the head.

Pronotum yellowish, anterior margin brown and rounded. Legs yellow.

Abdominal tergites brownish yellow with marginal bristles and microscopical hair which is hardly visible. Sternites yellow.

Measurements.—

Total length.....	4.00–4.25 mm.
Length of head.....	1.25–1.61 mm.
Width of head.....	.74–1.06 mm.
Length of antennae.....	1.61–1.73 mm.
Width of pronotum.....	.42–.55 mm.
Length of hind tibia.....	.96–1.22 mm.

Comparison with other species.—Very close to *N. costalis*, but the nose is generally more slender and the abdominal tergites do not have as conspicuous microscopical hair as in *N. costalis*.

Remarks.—The description of *N. klinckowstroemi* (Holmgren) agrees with this description and I am of the opinion expressed by Banks (1918) that they are the same species.

Type locality.—Ephrata, Surinam.

New localities.—British Guiana: Kartabo, Penal Settlement, Dunoon, Kaieteur; Trinidad: St. Joseph.

Range.—Surinam, British Guiana, Trinidad, Panama.

The description is based upon many winged imagos, kings, queens, and soldiers collected at Kartabo from twenty-four different colonies by the author; soldiers from Kaieteur collected by Mr. John Tee-Van from a single colony; winged imagos, queens and soldiers from Dunoon collected from a single colony by F. M. Gaige; kings, queens and soldiers from the Penal Settlement collected from 2 different colonies by the author; and soldiers from a single colony from Trinidad collected by the author.

Nasutitermes (*Nasutitermes*) *octopilis* Banks.

Nasutitermes octopilis Banks, 1918, p. 666 (soldier, biology), text-fig. (soldier).

(Fig. 56)

Imago.—Head brown, widely oval, Y-suture distinct; clothed with hairs and bristles. Fontanelle small, triangular.

Antennae yellowish, with 15 segments, the 2d, 3d, and 4th equal.

Eyes very large, prominent, and very close to the lower margin of the head. Ocelli very large, prominent, and very close to the eyes.

Labrum lighter than the head. Postclypeus lighter than the head, median line faint and indistinct.

Pronotum about the same color as the head or somewhat lighter, particularly near the middle; covered with hairs and bristles; a little narrower than the head, angles and sides rounded, posterior margin emarginate.

Posterior margins of the meso- and metanota widely emarginate.

Wings light yellow brown, the radius, media, and first few branches of the cubitus near the scale darker. All the veins in the outer half of the wing light.

Abdominal tergites about the same color as the head.

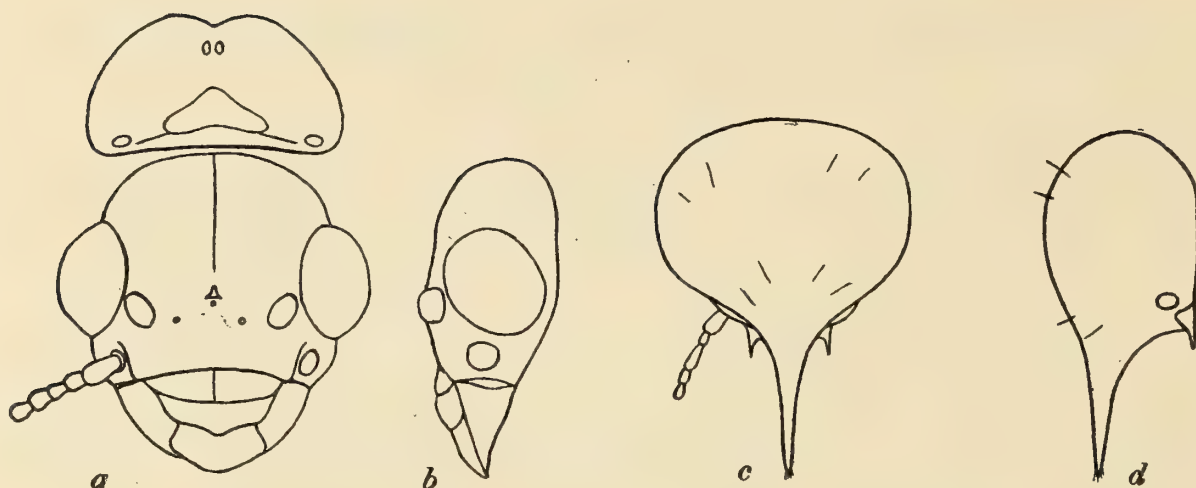


Fig. 56. *Nasutitermes* (*Nasutitermes*) *octopilis* Banks. *a*, imago, dorsal view of head and pronotum; *b*, imago, lateral view of head; *c*, soldier, dorsal view of head; *d*, soldier, lateral view of head.

Measurements.—

Length with wings.....	16.00–17.00 mm.
Length without wings.....	8.00– 9.50 mm.
Length of head.....	1.77– 1.92 mm.
Width of head.....	1.54– 1.61 mm.
Length of antennae.....	2.31– 2.73 mm.
Diameter of eye.....	.55– .61 mm.
Length of pronotum.....	.71– .74 mm.
Width of pronotum.....	1.36– 1.45 mm.
Length of hind tibia.....	1.86– 1.96 mm.
Length of anterior wing.....	12.50–13.95 mm.
Width of anterior wing.....	4.35– 4.49 mm.
Length of queen.....	23.00 mm.
Width of abdomen of queen.....	6.00 mm.

Comparison with other species.—The description of the imago of *N. acajutlae* is very close, but the soldier is quite different.

Soldier.—Head yellow, subglobular without nose, profile rather concave from the tip of the nose to the vertex; clothed with 4 bristles at the base of the nose and 4 on the vertex.

Antennae pale yellow, with 13 segments, the 3d longer than the 2d, the 2d equal to the 4th.

Nose light reddish brown, slender, of medium length.

Thorax same color as the head. Pronotum with minute hairs on the anterior margin and often a few bristles; front margin rounded.

Abdomen same color as the head. Tergites with a row of marginal bristles but no hair. Sternites hairy.

Measurements.—

Total length.....	4.70–5.00 mm.
Length of head.....	1.77–2.09 mm.

Measurements.—

Width of head	1.06–1.34 mm.
Length of antennae	1.51–1.64 mm.
Width of pronotum . . . . .	.51–.56 mm.
Length of hind tibia	1.24–1.28 mm.

Comparison with other species.—Differs from *N. rotundatus* Holmgren in that the tergites have no hair, but only marginal bristles.

Type locality.—Tukeit, British Guiana.
New localities.—British Guiana: Kartabo, Dunoon.
Range.—British Guiana.

The descriptions are based upon many winged imagos, soldiers, and four kings and queens from twenty different colonies collected by the author at Kartabo. Winged imagos and soldiers collected from two colonies at Dunoon by F. M. Gage agree with the Kartabo specimens.

Nasutitermes (*Nasutitermes*) *surinamensis* (Holmgren).
Eutermes surinamensis Holmgren (1910), p. 251 (soldier, worker), text-fig. 33 (soldier).

(Fig. 57 a, b, c, d)

Imago (queen).—Head dark, brown, oval; covered with hairs and long bristles. Fontanelle small, short, and forked at the tip.

Antennae broken, the 2d segment equal to the 3d, the 4th a little longer than the 3d.

Eyes large, not particularly prominent, fairly close to the lower margin of the head. Ocelli rather small, lying nearly flat on the head, slightly more than their diameter from the eyes.

Labrum a little lighter than the head. Postclypeus dark brown, median line absent or inconspicuous.

Pronotum dark brown, lighter in places than the head; narrower than the head, sides rounded, posterior margin deeply emarginate, angles rounded.

Posterior margins of the meso- and metanota widely emarginate, angles sharp or rounded.

Abdominal tergites dark brown.

Measurements.—

Length of head	1.96–1.99 mm.
Width of head	1.83–1.86 mm.
Diameter of eye . . . . .	.55–.57 mm.
Length of pronotum . . . . .	.87–.90 mm.
Width of pronotum	1.57–1.70 mm.
Length of hind tibia	1.93–2.02 mm.
Length of queen	27.00 mm.
Width of abdomen of queen	6.00 mm.

Soldier.—Head reddish brown, large, profile straight with elevation at the base of the nose hardly distinguishable; 4 bristles at the base of the nose and 2 on the vertex.

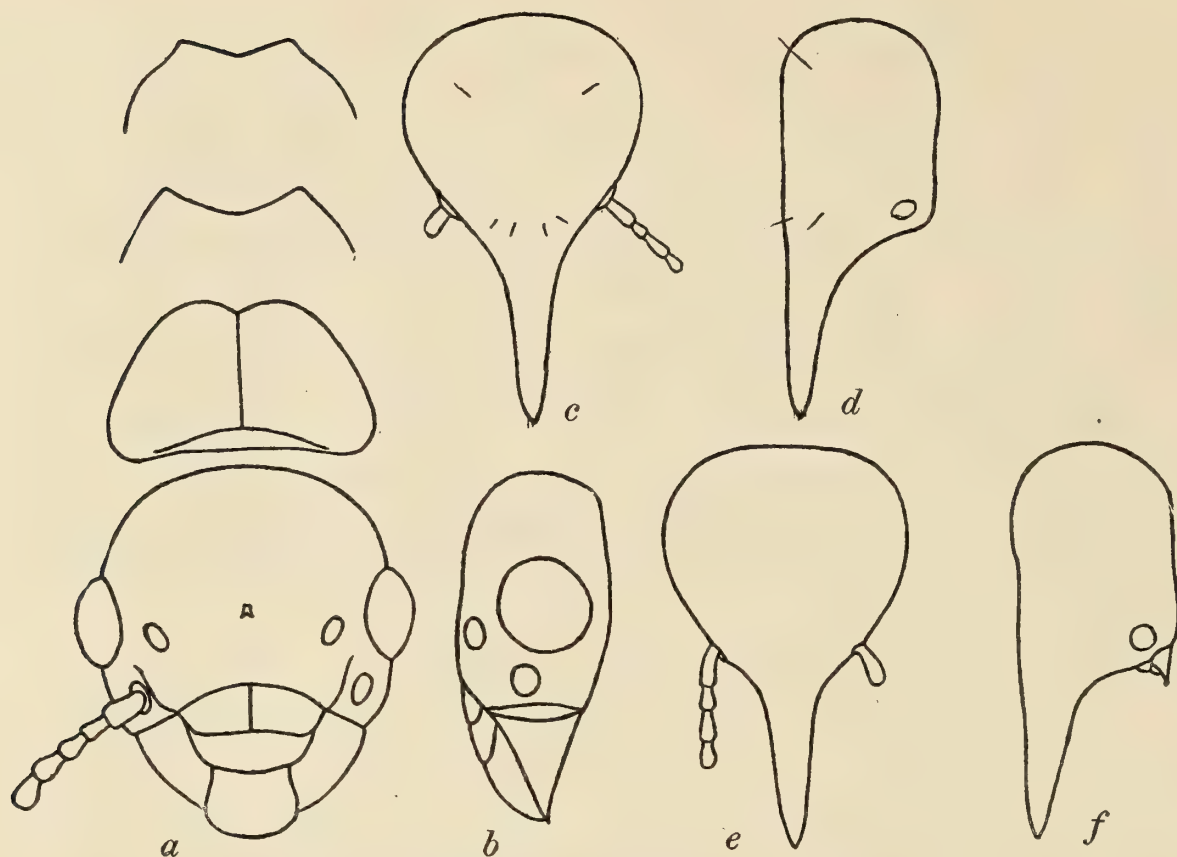


Fig. 57. *Nasutitermes* (*Nasutitermes*) *surinamensis* (Holmgren). *a*, imago, dorsal view of head, pronotum and margins of thoracic nota; *b*, imago, lateral view of head; *c*, soldier, dorsal view of head; *d*, soldier, lateral view of head.

Nasutitermes (*Nasutitermes*) *comstockae*, sp. nov. *e*, soldier, dorsal view of head; *f*, soldier, lateral view of head.

Antennae yellowish with 13 segments, the 3d longer than the 2d, the 4th equals the 2d or is somewhat longer.

Nose a little darker than the head, large and thick.

Pronotum yellowish, front margin brownish with short hairs and a few longer bristles. Legs yellowish.

Abdominal tergites yellowish, covered with long hairs and also with a row of marginal bristles.

Measurements.—

Total length.....	4.00–5.00 mm.
Length of head.....	1.65–1.83 mm.
Width of head.....	1.10–1.22 mm.
Length of antennae.....	1.80–1.90 mm.
Width of pronotum.....	.48–.61 mm.
Length of hind tibia.....	1.45–1.54 mm.

Type locality.—Surinam: Ephrata.

New localities.—British Guiana: Kartabo, Tukeit.

Range.—Surinam, British Guiana.

The description is based upon one king, two queens, and many soldiers collected by the author from seven different colonies at Kartabo. Soldiers collected from a single colony at Tukeit by Dr. F. E. Lutz agree with the Kartabo specimens.

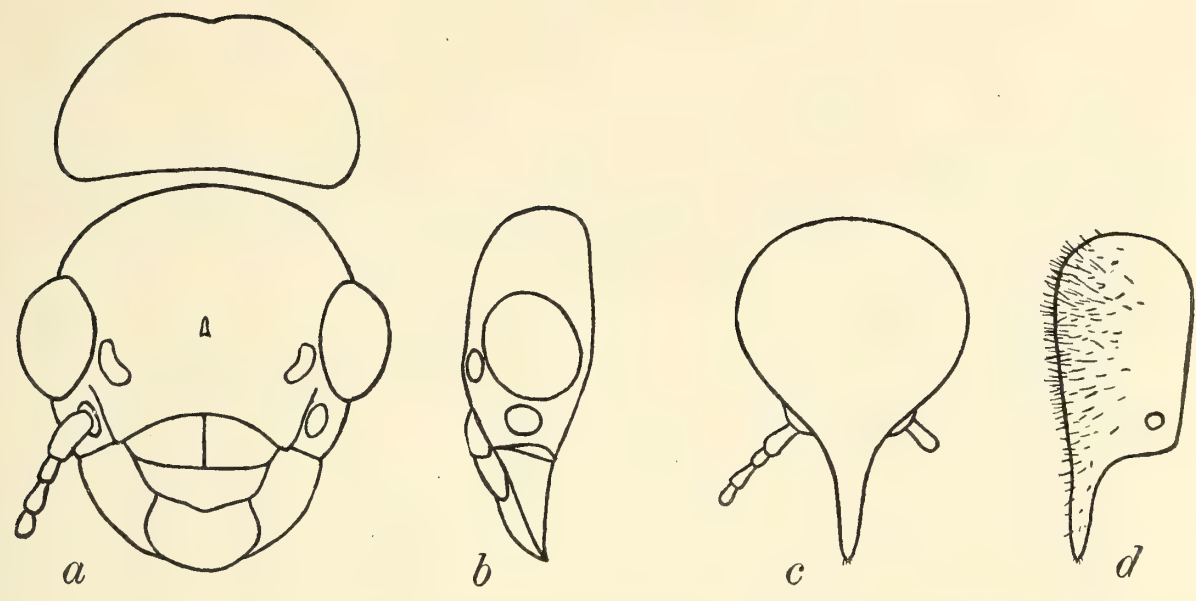


Fig. 58. *Nasutitermes (Nasutitermes) acajutlae* (Holmgren). *a*, imago, dorsal view of head and pronotum; *b*, imago, lateral view of head; *c*, soldier, dorsal view of head; *d*, soldier, lateral view of head.

Nasutitermes (Nasutitermes) acajutlae (Holmgren).

Eutermes Acajutlae Holmgren (1910), p. 262 (imago, soldier, worker),
text-fig. 42 (imago).
Nasutitermes creolina Banks (1919), p. 482, 484 (soldier only).

(Fig. 58)

Imago (queen).—Head dark brown, widely oval, covered with rather long hairs. Antennae yellow brown, the 3d segment longer than the 2d and slightly longer than the 4th.

Eyes very large and fairly prominent, very close to the lower margin of the head. Ocelli large, prominent, very close to the eyes.

Labrum yellow brown. Postclypeus yellow brown, with median line.

Pronotum yellow brown, contrasting with the head; clothed with many hairs and bristles which are thicker on the margins; angles and sides rounded, posterior margin somewhat emarginate.

Posterior margins of the meso- and metanota emarginate, angles rounded. Abdominal tergites lighter than the head.

Measurements.—

Length of head	2.02 mm.
Width of head	1.77 mm.
Diameter of eye . . . . .	.71 mm.
Length of pronotum . . . . .	.83 mm.
Width of pronotum	1.64 mm.
Length of hind tibia	1.80 mm.
Length of queen	26.50 mm.
Width of abdomen of queen	8.00 mm.

Soldier.—Head dark to medium dark reddish brown, lighter around the base of the antennae; thickly covered with long hairs and a few longer bristles; oval from above, profile nearly straight, slightly concave, a very slight elevation at the base of the nose.

Antennae yellowish, with 13 segments, the 3d longer than the 4th, the 4th somewhat longer than the 2d.

Nose with a few hairs; rather short and stout.

Thorax pale. Pronotum yellow, front margin brown and emarginate; covered with long hairs and a row of longer bristles on the front margin.

Legs yellow. Abdominal sternites and tergites yellow, thickly covered with long hairs in addition to rows of marginal bristles.

Measurements.—

Total length	5.00–6.00 mm.
Length of head	1.73–1.83 mm.
Width of head	1.05–1.16 mm.
Length of antennae	1.73–1.77 mm.
Width of pronotum	.61–.64 mm.
Length of hind tibia	1.38–1.51 mm.

Comparison with other species.—Distinguished from *N. pilifrons* (Holmgren) by the emarginate anterior margin of the pronotum.

Type locality.—San Salvador.

New localities.—British Guiana: Kartabo, Camaria, Dunoon; St. Croix.

Range.—British Guiana, St. Croix, St. Thomas, San Salvador.

The description is based upon a single queen and many soldiers from two different colonies collected by the author at Kartabo. Soldiers collected by the author from a single colony at Camaria, soldiers collected by F. M. Gaige from a single colony at Dunoon, two queens and many soldiers collected by the author from four colonies at St. Croix, W. I., and one queen and many soldiers collected from five different colonies by the author at St. Thomas, W. I., all agree with the Kartabo specimens.

Although the soldier of *N. creolina* Banks is undoubtedly the same species as *N. acajutlae*, the imago he describes from Monserrat does not belong with the soldier. As *N. creolina* is based on the soldier, this name must go into the synonymy of *N. acajutlae*.

Nasutitermes (*Nasutitermes*) *intermedius* Banks.

Nasutitermes intermedius Banks (1919), p. 485, 482 (soldier, worker), pl. 2, fig. 13, 25 (soldier).

(Fig. 59)

Imago.—Head rather dark brown, widely oval. Fontanelle 3-pointed, nearly as long as the ocelli or longer, no conspicuous line from the fontanelle to the posterior margin as in *N. octopolis*.

Antennae with 15 segments, the 3d sometimes showing signs of dividing.

Eyes large, very close to the lower margin of the head. Ocelli large but proportionately smaller than in *N. octopolis*, very close to the eyes.

Labrum reddish yellow. Postclypeus reddish yellow, median line faint.

Pronotum reddish yellow, much lighter than the head; hind margin not, or very weakly emarginate, sides rounded, angles rounded.

Posterior margins of the meso- and metanota not very strongly emarginate, angles fairly sharp.

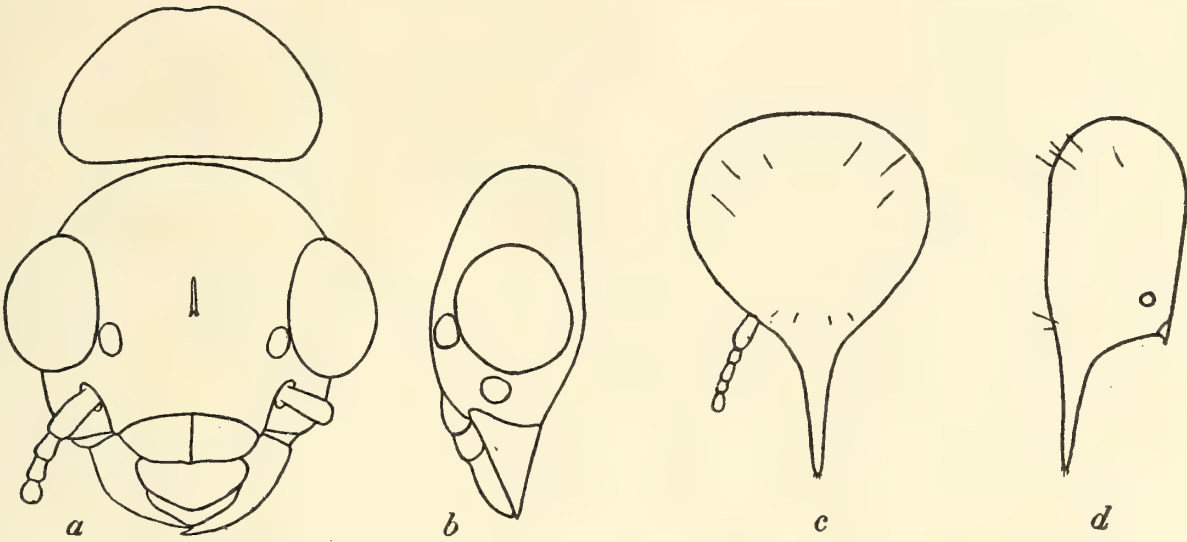


Fig. 59. *Nasutitermes (Nasutitermes) intermedius* Banks. *a*, imago, dorsal view of head and pronotum; *b*, imago, lateral view of head; *c*, soldier, dorsal view of head; *d*, soldier, lateral view of head.

Wings brownish yellow, veins darker near the base.
Abdominal tergites brown, sternites yellowish in the middle.

Measurements.—

Length with wings.....	13.50–15.00 mm.
Length without wings.....	7.00– 8.50 mm.
Length of head.....	1.45– 1.64 mm.
Width of head.....	1.38– 1.45 mm.
Length of antennae.....	1.93 mm.
Diameter of eye.....	.54– .58 mm.
Length of pronotum.....	.64– .67 mm.
Width of pronotum.....	1.09– 1.22 mm.
Length of hind tibia.....	1.48 mm.
Length of anterior wing.....	10.87–11.11 mm.
Width of anterior wing.....	3.19 mm.

Comparison with other species.—I am much inclined to believe that this species is *N. montanae* (Holmgren) as Holmgren’s description is very close. However, he states (1910), that the antennae of *N. montanae* are 16-segmented while the specimens from Kartabo rarely have even an indication of a 16th segment. Also the fontanelle of the Kartabo specimens seems to be larger than in the figure of *M. montana*, so I have decided to keep the names separated until more material can be examined.

Soldier.—Head brown, roundly oval without the nose; clothed with a number of bristles, 4 at the base of the nose and from 6–10 on the vertex.

Antennae lighter than the head, with 13 segments, the 3d longer than the 2d, the 2d longer than the 4th.

Nose same color as the head, slender and of medium length.

Thorax yellow brown. Pronotum with marginal bristles and very short hairs; anterior region not particularly raised. Abdominal tergites with short hairs in addition to a row of marginal bristles. Sternites with long hair. Abdomen yellow brown.

Measurements.—

Total length.....	3.50–4.50 mm.
Length of head.....	1.54 mm.
Width of head.....	.96–1.05 mm.
Length of antennae.....	1.35–1.38 mm.
Width of pronotum.....	.46 mm.
Length of hind tibia.....	.87–.93 mm.

Comparison with other species.—Easily distinguished from *N. guayanae* by the presence of short hairs in addition to marginal bristles on the abdominal tergites. Also the nose is more slender.

Type locality.—Arepo Savanna, Trinidad.

New locality.—Kartabo, British Guiana.

Range.—British Guiana, Trinidad.

The description is based upon many winged imagos and soldiers taken from seven different colonies by the author at Kartabo. The soldiers agree perfectly with specimens from Trinidad determined by Banks.

Nasutitermes (Nasutitermes) comstockae, sp. nov.

(Fig. 57 e, f)

Soldier.—Head reddish brown, profile straight with a very slight elevation at the base of the nose; usually with 4 bristles at the base of the nose and 2 on the vertex.

Antennae yellowish, with 12–13 segments. If with 13 segments, the 3d is longer than the 4th and the 4th is somewhat longer than the 2d.

Nose darker than the head, proportionately very large and thick.

Pronotum with a few bristles and many short hairs; anterior margin brownish.

Legs yellowish. Abdomen yellowish; tergites covered with long hair and longer bristles on the margins.

Measurements.—

Total length.....	4.00–4.20 mm.
Length of head.....	1.48–1.70 mm.
Width of head.....	.80–1.00 mm.
Length of antennae.....	1.61–1.93 mm.
Width of pronotum.....	.38–.55 mm.
Length of hind tibia.....	1.25–1.35 mm.

Comparison with other species.—Close to *N. surinamensis*, but differs in the proportionately narrower head and somewhat thicker nose besides the much smaller size. Differs from *N. hubbardi* Banks in having no minute hairs on the head.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Soldier.

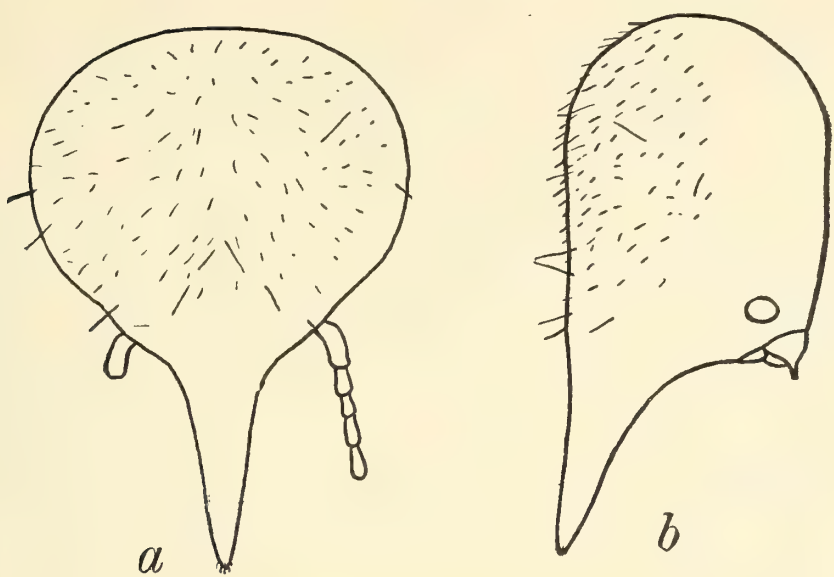


Fig. 60. *Nasutitermes (Nasutitermes) wheeleri*, sp. nov. *a*, soldier, dorsal view of head; *b*, soldier, lateral view of head.

Described from numerous specimens of soldiers collected by the author from two different colonies at Kartabo. I take pleasure in naming this species after Mrs. A. B. Comstock, to whom I owe much of my early training and enthusiasm for the study of biology.

***Nasutitermes (Nasutitermes) wheeleri*, sp. nov.**
(Fig. 60)

Winged nymph.—Antennae with 15 segments. Eyes not very large. Ocelli rather far from the eyes. Posterior margin of the pronotum conspicuously emarginate.

Soldier.—Head dark reddish brown, wide, globular; profile rather straight or slightly concave, with an elevation at the base of the nose; clothed with hairs which are shorter than those of *N. acajutlae*, longer bristles also visible, 4 at the base of the nose and 4 on the vertex.

Antennae yellowish except near the base, with 14 segments, the 3d shorter than the 2d, the 2d about as long as the 4th.

Nose about the same color as the rest of the head, of medium length and thickness, without hairs except at the tip.

Pronotum dark brown, front margin with long bristles and short hairs, somewhat emarginate. Legs brownish yellow.

Abdominal tergites dark brown, covered thickly with hair and the margins with a row of bristles. Sternites lighter.

Measurements.—

Total length.....	4.00–5.00 mm.
Length of head.....	1.64–1.80 mm.
Width of head.....	1.16–1.25 mm.
Length of antennae.....	1.93 mm.
Width of pronotum.....	.55–.61 mm.

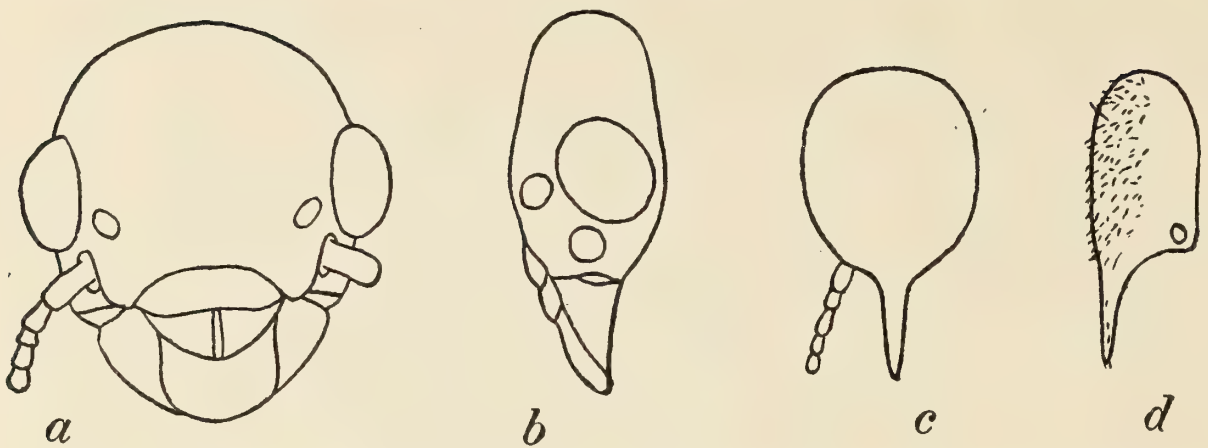


Fig. 61. *Nasutitermes (Nasutitermes) banksi*, sp. nov. *a*, imago, dorsal view of head; *b*, imago, lateral view of head; *c*, soldier, dorsal view of head; *d*, soldier, lateral view of head.

Measurements.—

Length of hind tibia 1.28–1.32 mm.

Comparison with other species.—*N. pilifrons* (Holmgren) has a lighter colored abdomen, antennae with 13 segments, and is on the average smaller. *N. arenarius* (Bates) (Holmgren) has a less hairy head. *N. acajutlae* (Holmgren) has yellow tergites and the nose has a few hairs.

The description is based upon many soldiers and winged nymphs collected by the author from a single queenless colony at Kartabo. I take pleasure in naming this species in honor of Prof. Wm. M. Wheeler, who was a constant inspiration to me during my studies at Kartabo.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Soldier.

***Nasutitermes (Nasutitermes) banksi*, nom. nov.**

. *Nasutitermes holmgreni* Banks (1918), p. 667 (soldier), *text-fig.* (soldier).

(Fig. 61)

Another species of the genus *Nasutitermes* belonging to the subgenus *Trinervitermes* was described by von Rosen (1912) from Liberia under the name *Eutermes Holmgreni*. Therefore it is necessary to change the name of the British Guiana species and I take the opportunity to name it after Mr. Nathan Banks, who first described the species.

Imago.—Head brownish black, oval, covered with hair and a few long bristles. Fontanelle inconspicuous.

Antennae with 13–14 segments. If with 13 segments, the 3d is longer than the 2d, the 2d is equal to the 4th. If with 14 segments, the 3d is very short, the 4th is shorter than the 2d and the 2d is equal to the 5th.

Eyes large, prominent and quite close to the lower margin of the head. Ocelli large, about $\frac{1}{2}$ their width removed from the eyes.

Labrum lighter than the head. Postclypeus lighter than the head, median line faint.

Pronotum brown, much lighter than the head, posterior margin emarginate.

Posterior margins of the meso- and metanota widely emarginate. Legs brownish, lighter than the prothorax.

Wings rather dark, smoky. Abdominal tergites brown. Sternites light in the middle.

Measurements.—

Length with wings.....	10.50–11.00 mm.
Length without wings.....	5.50– 6.50 mm.
Length of head.....	1.09– 1.16 mm.
Width of head.....	.96– 1.03 mm.
Length of antennae.....	1.28– 1.45 mm.
Diameter of eye.....	.32 mm.
Length of pronotum.....	.42– .45 mm.
Width of pronotum.....	.71– .80 mm.
Length of hind tibia.....	1.00 mm.
Length of anterior wing.....	8.39– 8.75 mm.
Width of anterior wing.....	2.36– 2.48 mm.

Soldier.—Head dark reddish brown, darkest at the base of the nose, profile convex with no elevation at the base of the nose. Top of head covered with short hairs and a few longer bristles at the base of the nose and on the vertex.

Antennae yellowish, 11–12-segmented. If with 11 segments, the 3d is much longer than the 2d or 4th and the 2d is slightly longer than the 4th. If with 12 segments, the 3d is very short, the 4th equals the 5th and the 2d is slightly longer than the 4th.

The tip of the nose is a little lighter than the rest of the head. The nose is of medium length with a few microscopical hairs scattered over it.

Thorax brown. Front margin of pronotum dark brown, not emarginate. Legs brownish yellow.

Abdominal tergites brown, lighter than the head. Sternites yellowish. Tergites covered with microscopical hair, posterior margins with a single row of long bristles.

Measurements.—

Total length.....	2.40–3.40 mm.
Length of head.....	1.06–1.26 mm.
Width of head.....	.67– .74 mm.
Length of antennae.....	.96–1.12 mm.
Width of pronotum.....	.29– .32 mm.
Length of hind tibia.....	.58– .64 mm.

Type locality.—Tukeit, British Guiana.

New locality.—Kartabo, British Guiana.

Range.—Known only from British Guiana.

The description is based upon many winged imagos and soldiers from eleven different colonies collected by the author at Kartabo, and from soldiers collected from a single colony at Kartabo by Dr. Wm. M. Wheeler.

Nasutitermes (Nasutitermes) gagei, sp. nov.

(Fig. 62.)

Imago.—Head dark brown, a little lighter on the queen, oval; covered with hairs and a few bristles. Fontanelle fairly large and distinct, forked at the tip.

Antennae lighter than the head, with 15 segments, the 2d equals the 3d, the 4th is a little shorter but wider than the 3d.

Eyes of medium size, fairly prominent and fairly close to the lower margin of the head. Ocelli of medium size, a little less than their length removed from the eyes.

Labrum lighter than the head. Postclypeus lighter than the head and with a median line.

Pronotum nearly as dark as the head, covered with hair and a few longer bristles; sides slightly rounded, posterior margin nearly straight or rounded, very rarely slightly emarginate.

Posterior margins of meso- and metanota widely emarginate, angles rather sharp.

Wings rather dark and smoky, a light streak visible between the media and cubitus, particularly near the base.

Abdominal tergites nearly as dark as the head.

Measurements.—

Length with wings	9.00–9.60 mm.
Length without wings	5.00–6.00 mm.
Length of head . . . . .	.96–1.06 mm.
Width of head . . . . .	.86– .93 mm.
Length of antennae	1.61–1.70 mm.
Diameter of eye . . . . .	.26– .29 mm.
Length of pronotum . . . . .	.45– .46 mm.
Width of pronotum . . . . .	.74– .77 mm.
Length of hind tibia	1.06–1.09 mm.
Length of anterior wing	6.85–7.45 mm.
Width of anterior wing	2.01–2.13 mm.
Length of queen	11.00 mm.
Length of king	4.50 mm.

Comparison with other species.—Very close to Holmgren's (1910) description of *N. longirostratus*, but *N. gagei* is smaller in all measurements.

Soldier.—Head brownish yellow, oval, profile with a slight elevation at the base of the nose; 4 bristles at the base of the nose and 2 on the vertex.

Antennae yellowish, with 13 segments, the 3d equal to or slightly longer than the 2d, the 4th shorter than the 2d.

Mandibles with a distinct sharp point.

Nose dark brown, slender and rather long.

Thorax yellowish. Pronotum with a fringe of very short hair on the front margin, no bristles present; front margin not emarginate.

Legs yellowish. Abdomen yellowish; tergites covered with microscopical hairs and a single row of bristles on the posterior margins.

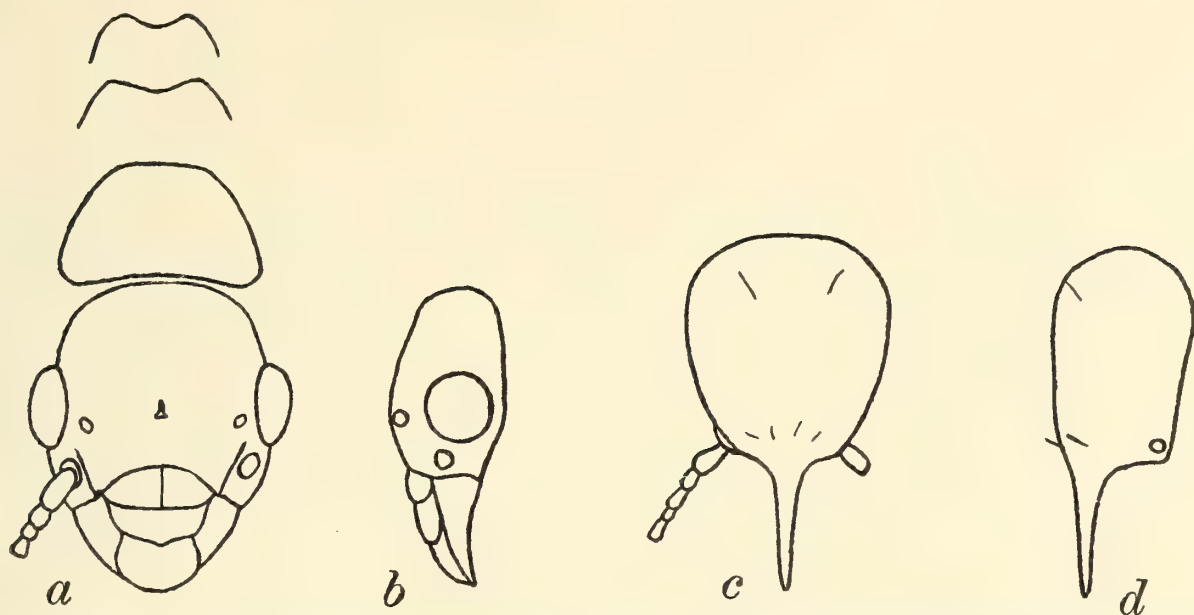


Fig. 62. *Nasutitermes (Nasutitermes) gaigei*, sp. nov. *a*, imago, dorsal view of head, pronotum and margins of thoracic nota; *b*, imago, lateral view of head; *c*, soldier, dorsal view of head; *d*, soldier, lateral view of head.

Measurements.—

Total length	3.00–3.50 mm.
Length of head	1.16–1.24 mm.
Width of head . . . . .	.57–.61 mm.
Length of antennae	1.36–1.45 mm.
Width of pronotum . . . . .	.32–.38 mm.
Length of hind tibia . . . . .	.70–.80 mm.

Comparison with other species.—Very close to *N. longirostratus*, but smaller in all measurements.

Type locality.—Kartabo, British Guiana.

Other locality.—Dunoon, British Guiana.

Range.—Known only from British Guiana.

Holotype.—Winged imago.

Morphotype.—Soldier.

The description is based upon several winged imagos, several kings and queens and many soldiers collected by the author from ten different colonies at Kartabo, and upon several winged imagos and soldiers collected by F. M. Gaige from a single colony at Dunoon. I take pleasure in naming the species in honor of Dr. Gaige.

***Nasutitermes (Nasutitermes) brevipilus*, sp. nov.**

(Fig. 63)

Imago.—Head dark brown, oval, covered with short hair and a few long bristles. Fontanelle short, but conspicuous, forked at the tip.

Antennae with 15 segments, the 3d smaller than the 2d or 4th, the 2d equal to the 4th.

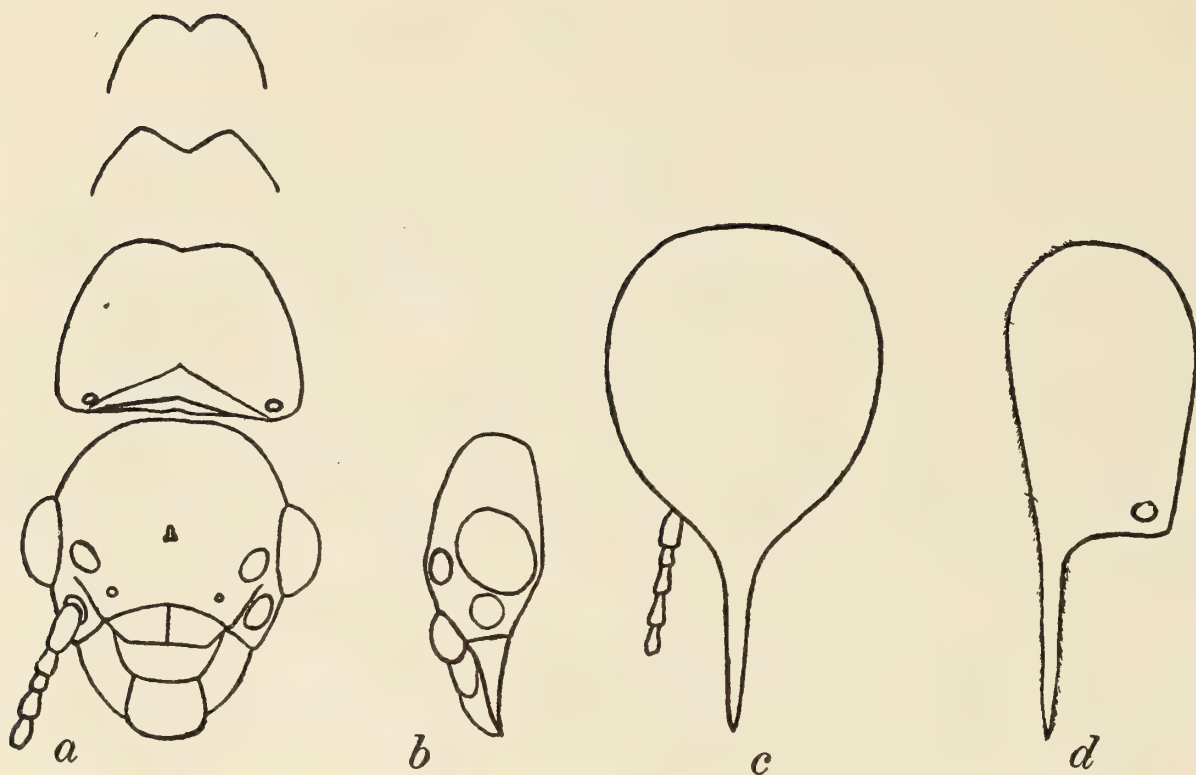


Fig. 63. *Nasutitermes* (*Nasutitermes*) *brevipilus*, sp. nov. *a*, imago, dorsal view of head, pronotum and margins of thoracic nota; *b*, imago, lateral view of head; *c*, soldier, dorsal view of head; *d*, soldier, lateral view of head.

Eyes proportionately large and prominent, close to the lower margin of head. Ocelli large and fairly close to the eyes (.033 mm. removed).

Postclypeus lighter than the head, median line rather faint.

Pronotum brown, a little lighter than the head; sides rounded, posterior margin somewhat emarginate, anterior angles fairly sharp.

Posterior margins of the meso- and metanota deeply emarginate.

Wings smoky, a light streak between the media and cubitus.

Abdominal tergites about the same color as the pronotum.

Measurements.—

Length with wings	11.50–12.00 mm.
Length without wings	6.80– 7.20 mm.
Length of head	1.10– 1.17 mm.
Width of head . . . . .	.96– 1.07 mm.
Length of antennae	1.73– 1.83 mm.
Diameter of eye . . . . .	.37 mm.
Length of pronotum . . . . .	.48– .57 mm.
Width of pronotum . . . . .	.77– .83 mm.
Length of hind tibia	1.43– 1.47 mm.
Length of anterior wing	8.80– 9.62 mm.
Width of anterior wing	2.40– 2.88 mm.

Soldier.—Head yellow, widely oval without the nose, profile concave with no elevation at the base of the nose; thickly covered with minute hairs and a few short bristles at the base of the nose and on the vertex.

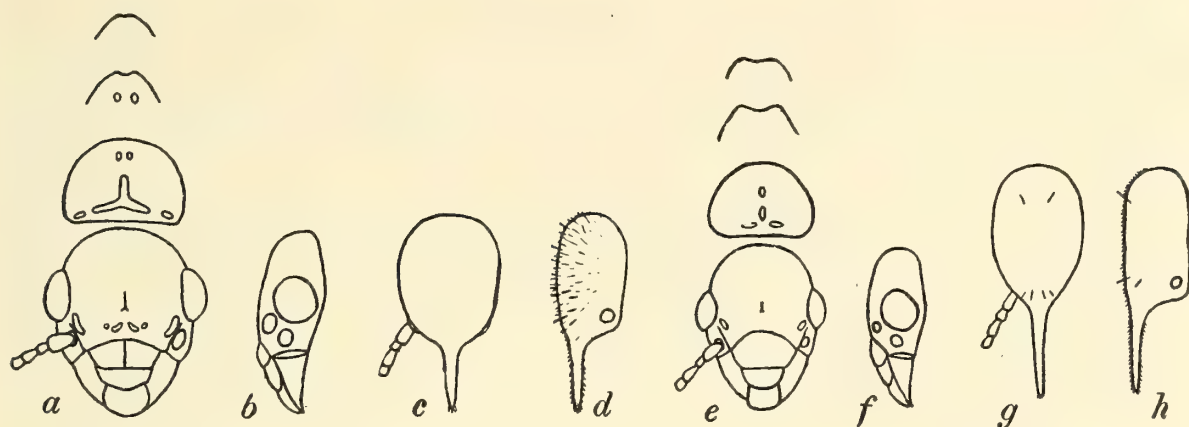


Fig. 64. *Nasutitermes* (*Subulitermes*) *parvellus* (Silvestri). *a*, imago, dorsal view of head, pronotum and margins of thoracic nota; *b*, imago, lateral view of head; *c*, soldier, dorsal view of head; *d*, soldier, lateral view of head.

Nasutitermes (*Subulitermes*) *baileyi*, sp. nov. *e*, imago, dorsal view of head, pronotum and margins of thoracic nota; *f*, imago, lateral view of head; *g*, soldier, dorsal view of head; *h*, soldier, lateral view of head.

Antennae with 12 segments, the 2d shorter than the 3d, the 3d equal to the 4th. Mandibles with a distinct point.

Nose slightly darker than the rest of the head, very slender and quite long.

Pronotum yellow with minute hairs on the margins; anterior region sharply raised.

Abdomen the color of the contents of the intestines. Tergites covered with short hairs and a row of short bristles on the posterior margins.

Measurements.—

Total length	4.00–4.30 mm.
Length of head	1.35–1.70 mm.
Width of head	.64–.73 mm.
Length of antennae	1.15–1.40 mm.
Width of pronotum	.43–.46 mm.
Length of hind tibia	.86–.96 mm.

Comparison with other species.—Differs from all other New World species of this subgenus in having very short hair on the head and the profile concave with a long and slender nose.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Imago.

Morphotype.—Soldier.

Described from many winged imagos and soldiers collected by the author from five different colonies at Kartabo.

Subgenus *Subulitermes* Holmgren

Including the species described in this report, this subgenus now comprises fifteen species which are rather widely distributed. There are four species reported from the Oriental region, two from Africa, one from Australia and eight from the Neotropical region. The species are usually rather small and inconspicuous and it is my belief that many forms of the group will ultimately be discovered.

Six species were found in British Guiana and all seem to be new with the exception of one species recently described by Silvestri. Several of these species have slight constrictions of the head and I believe that some of the small species described by Banks and included in the genus *Constrictotermes* may belong to this subgenus.

Holmgren (1910) described a species of this subgenus under the name *Eutermes incola*. Wasmann (1893) had already described a species under the name *Eutermes incola* which is now placed in the genus *Capritermes*. Therefore *Eutermes incola* Holmgren must be given a new name. I suggest the name *Nasutitermes* (*Subulitermes*) *thompsonae*, new name for this species in honor of the late Prof. Caroline B. Thompson of Wellesley College, who has added much to our knowledge of termite morphology.

***Nasutitermes* (*Subulitermes*) *baileyi*, sp. nov.**

(Fig. 64 *e, f, g, h*)

Imago.—Head dark brown, oval, narrow; covered with very short hairs and a few longer bristles. Fontanelle very small, slit-shaped and forked at the tip.

Antennae dark, with 14 segments, the 3d longer than the 2d, the 4th slightly shorter than the 2d.

Eyes fairly large, rather close to the lower margin of the head. Ocelli of medium size, less than half their length removed from the eyes.

Labrum light. Postclypeus nearly as dark as the head, large, median line absent, posterior border strongly curved.

Pronotum nearly as dark as the head, semicircular in outline; sides and posterior margin making an even curve without an emargination; a T-shaped series of marks in the middle.

Posterior margins of the meso- and metanota widely emarginate.

Wings dark smoky with a lightish streak between the media and cubitus, radius and first few branches of the cubitus dark. Abdominal tergites dark.

Measurements.—

Length with wings	8.50–9.00 mm.
Length without wings	5.00–6.00 mm.
Length of head . . . . .	.80–.86 mm.
Width of head . . . . .	.64–.69 mm.
Length of antennae	1.33–1.38 mm.
Diameter of eye . . . . .	.20 mm.
Length of pronotum . . . . .	.40–.43 mm.
Width of pronotum . . . . .	.57–.61 mm.
Length of hind tibia . . . . .	.94–.97 mm.
Length of anterior wing	5.69–6.40 mm.
Width of anterior wing	1.53–1.64 mm.

Comparison with other species.—Differs from *N. microsoma* in the darker color, smaller fontanelle and smaller pronotum.

Soldier.—Head yellow with reddish brown nose, profile straight with a

slight elevation at the base of the nose, oval from above without the nose; covered with short hair and also with 4 rather short bristles at the base of the nose and 2 on the vertex.

Antennae with 11 segments, the 3d longer than the 2d, the 2d equal to the 4th.

Nose darker than the head, long and slender, covered with short hair.

Pronotum pale yellow. Abdominal tergites with short hair and very short marginal bristles which are only a little longer than the hair. Abdomen pale yellow.

Measurements.—

Total length.....	2.70–3.50 mm.
Length of head.....	1.03–1.12 mm.
Width of head.....	.45–.48 mm.
Length of antennae.....	.86–1.00 mm.
Width of pronotum.....	.30 mm.
Length of hind tibia.....	.50 mm.

Comparison with other species.—Close to *N. microsoma*, but the soldier is smaller.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Winged imago.

Morphotype.—Soldier.

The descriptions are based upon many winged imagos, a single king and queen, and many soldiers collected from six different colonies at Kartabo by the author. *

The species is named in honor of Dr. I. W. Bailey of Bussey Institution, who helped me considerably in my work on termites at Kartabo.

Nasutitermes (Subulitermes) parvellus Silvestri.

Eutermes parvellus Silvestri (1923), p. 307 (imago, soldier, worker), pl. XI (imago, soldier).

(Fig. 64 a, b, c, d)

Imago.—Head brown, speckled minutely, lighter on the sides and around the antennae; oval; covered with fairly long hairs. Fontanelle slit-shaped, about as long as the ocelli, forked at the tip. Muscle insertions conspicuous.

Antennae pale, with 14 segments, the 2d, 3d, and 4th equal or the 3d slightly longer than the others.

Eyes fairly large, not particularly prominent, very close to the lower margin of the head. Ocelli proportionately large, close to the eyes.

Labrum pale. Postclypeus pale, with a median line.

Pronotum lighter than the head, a T-shaped light mark in the middle; half-moon-shaped, sides and posterior margin forming a perfect curve.

Posterior margins of meso- and metanota minutely emarginate, sides strongly converging.

Wings pale smoky, costal margin light near the apex, radius dark near the base.

Abdominal tergites same color as the pronotum

Measurements.—

Length with wings.....	9.00-10.00 mm.
Length without wings.....	6.00- 6.50 mm.
Length of head.....	.90 mm.
Width of head.....	.73- .77 mm.
Length of antennae.....	1.17- .138 mm.
Diameter of eye.....	.27 mm.
Length of pronotum.....	.33- .40 mm.
Width of pronotum.....	.53- .57 mm.
Length of hind tibia.....	.80 mm.
Length of anterior wing.....	6.56- 7.00 mm.
Width of anterior wing.....	1.77- 1.90 mm.

Soldier.—Head yellow, oval, profile flatly convex; covered with small hairs, longer hairs on the forehead and vertex.

Antennae pale, with 12 segments, the 3d longer than the 2d, the 2d equal to the 4th.

Nose dark, straight and slender, covered with small hairs.

Pronotum pale. Abdomen pale; tergites covered with long hairs, posterior margins with a single row of bristles.

Measurements.—

Total length.....	2.30-4.00 mm.
Length of head.....	.95-1.03 mm.
Width of head.....	.53- .57 mm.
Length of antennae.....	.86-1.00 mm.
Width of pronotum.....	.31 mm.
Length of hind tibia.....	.52- .57 mm.

Comparison with other species.—Differs from *N. microsoma* and *N. thompsonae* in having comparatively long hair on the head and abdominal tergites.

Type locality.—British Guiana: Kartabo.

New localities.—British Guiana: Potaro River, Dunoon; Trinidad: Port of Spain.

Range.—British Guiana, Trinidad.

The description is based upon many winged imagos and soldiers collected from nine different colonies at Kartabo by the author. Soldiers collected from a single colony at Dunoon by F. M. Gaige and soldiers collected from three different colonies at Trinidad by the author agree with the Kartabo specimens.

***Nasutitermes (Subulitermes) oculatissimus*, sp. nov.**

(Fig. 65)

Imago.—Head dark brown, oval; covered with rather long hair and a few long bristles. Fontanelle slit-shaped, forked at the tip.

Antennae with 14 segments, the 3d a little longer than the 2d, the 4th shorter than the 2d.

Eyes very large and prominent, very close to the lower margin of the head. Ocelli very large and prominent, very close to the eyes.

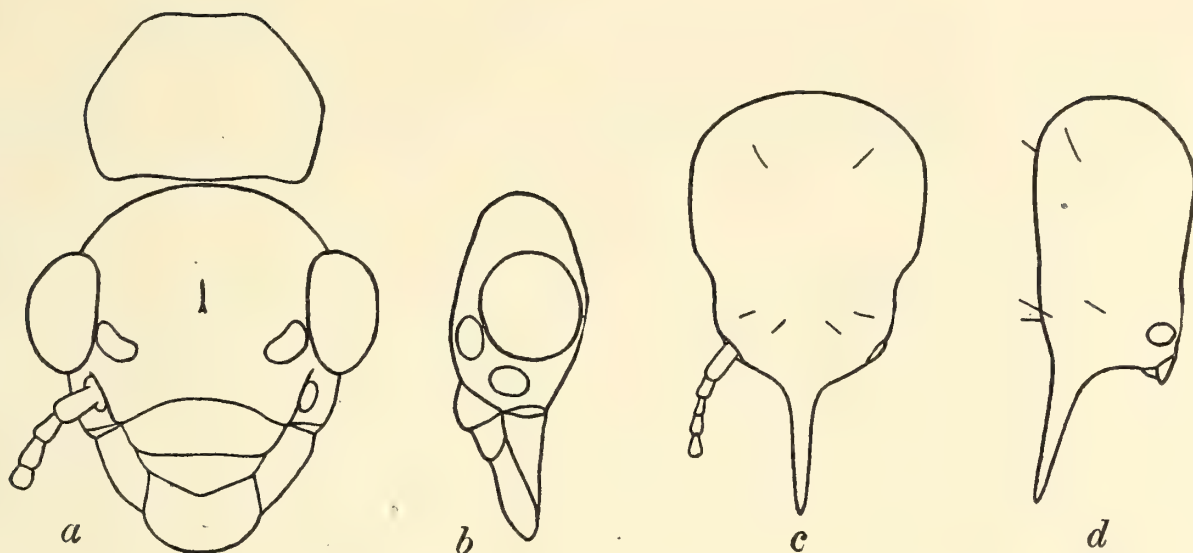


Fig: 65. *Nasutitermes* (*Subulitermes*) *oculatissimus*, sp. nov. a, imago, dorsal view of head and pronotum; b, imago, lateral view of head; c, soldier, dorsal view of head; d, soldier, lateral view of head.

Labrum brownish yellow. Postclypeus a little lighter than the head, median line inconspicuous.

Pronotum same color as the postclypeus, sides somewhat angular, anterior angles rather sharp, posterior margin nearly straight.

Posterior margins of the meso- and metanota rather widely emarginate.

Wings dark smoky, a light streak between the media and cubitus.

Abdominal tergites about the same color as the pronotum.

Measurements.—

Length with wings.....	9.50–10.00 mm.
Length without wings.....	5.00– 6.00 mm.
Length of head.....	1.00– 1.03 mm.
Width of head.....	.90 mm.
Length of antennae.....	1.80 mm.
Diameter of eye.....	.33 mm.
Length of pronotum.....	.50 mm.
Width of pronotum.....	.73 mm.
Length of hind tibia.....	1.20– 1.23 mm.
Length of anterior wing.....	8.50 mm.
Width of anterior wing.....	2.50 mm.

Comparison with other species.—Differs from *N. osborni* in being smaller and the ocelli are much larger. The eyes are proportionately as large as in *N. osborni*.

Soldier.—Head yellow, oval from above, with a conspicuous constriction behind the base of the antennae, profile with a slight indentation in the middle, fairly straight; 4 bristles at the base of the nose and 2 on the vertex, no short hairs present.

Antennae with 12 segments, the 3d smaller than the 2d, the 2d equal to the 4th. Mandibles without sharp points.

Nose brown, of medium length and slender, slightly pointed up in the profile; without hair except at the tip.

Thorax pale. Abdomen the color of the contents of the intestines; tergites with a row of bristles on the posterior margins and a few inconspicuous microscopical hairs scattered over the surface.

Measurements.—

Total length.....	3.00–3.30 mm.
Length of head.....	1.13–1.16 mm.
Width of head.....	.57 mm.
Length of antennae.....	1.23 mm.
Width of pronotum.....	.37 mm.
Length of hind tibia.....	.77–.80 mm.

Comparison with other species.—Nose proportionately shorter than in *N. osborni* and profile with a more conspicuous elevation at the base of the nose.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Winged imago.

Morphotype.—Soldier.

The description is based upon several winged imagos and numerous soldiers collected from a single colony by the author at Kartabo.

Nasutitermes (Subulitermes) raripilus, sp. nov.

(Fig. 66)

Imago (queen).—Head dark brown, widely oval, covered with long bristles and hairs. Fontanelle about as long as the ocelli, forked at the tip.

The 2d, 3d, and 4th segments of the antennae about equal in length, the 3d narrowest and just dividing from the 4th.

Eyes prominent, fairly large, close to the lower margin of the head. Ocelli large and prominent, about $\frac{2}{3}$ their length from the eyes.

Labrum yellow brown. Postclypeus somewhat lighter than the head, median line present.

Pronotum nearly as dark as the head, an indistinct T-shaped light mark in the middle; relatively wide, sides only slightly rounded, posterior margin nearly straight, posterior angles rather sharply rounded.

Posterior margins of meso- and metanota widely emarginate.

Abdominal tergites about the same color as the pronotum.

Measurements.—

Length of head.....	1.08 mm.
Width of head.....	1.03 mm.
Diameter of eye.....	.30 mm.
Length of pronotum.....	.52 mm.
Width of pronotum.....	.87 mm.
Length of hind tibia.....	1.17 mm.

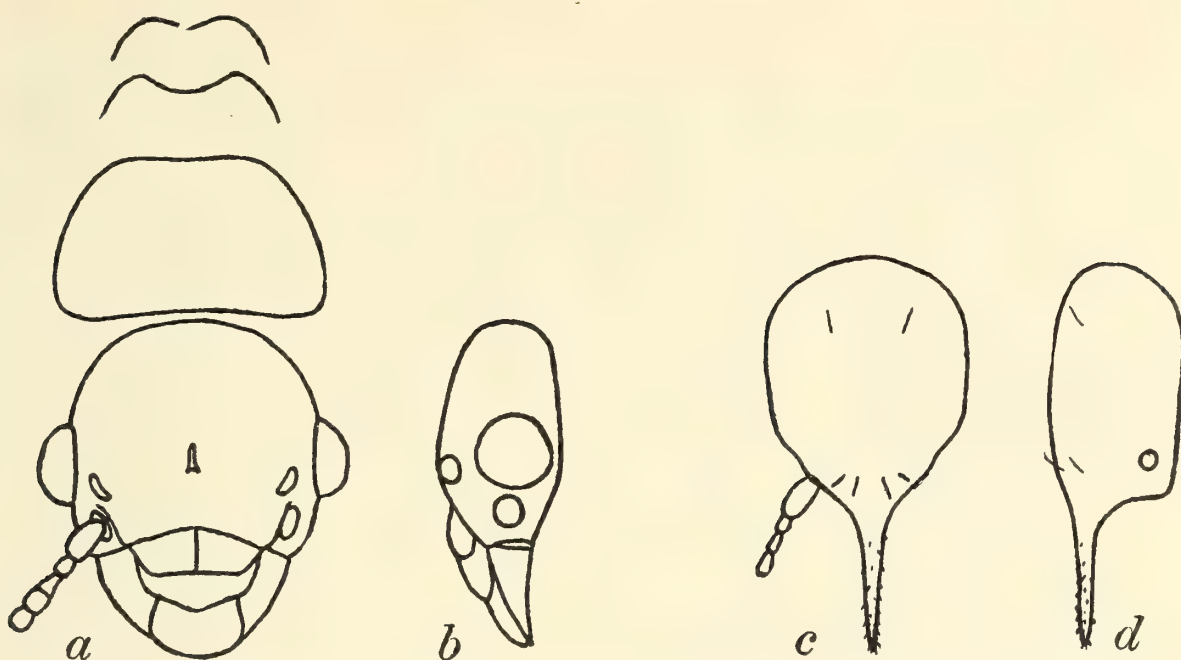


Fig. 66. *Nasutitermes* (*Subulitermes*) *raripilus*, sp. nov. *a*, imago, dorsal view of head, pronotum and margins of thoracal nota; *b*, imago, lateral view of head; *c*, soldier, dorsal view of head; *d*, soldier, lateral view of head.

Measurements.—

Length of queen 16.00 mm.

Width of abdomen of queen 3.00 mm.

Soldier.—Head yellow, oval from the top with a slight constriction in back of the base of the antennae, profile from base of nose to rear margin convex; smooth except for 4 bristles at base of nose and 2 on the vertex.

Antennae with 11–12 segments, the first segments variable in size.

Nose brown, slender and long, end covered with microscopical hairs.

Thorax pale. Pronotum with short hairs and a few long bristles on the front margin.

Abdominal tergites with very short hairs and a row of marginal bristles; pale.

Total length 3.50–4.50 mm.

Length of head 1.22–1.38 mm.

Width of head69–.77 mm.

Length of antennae 1.22–1.33 mm.

Width of pronotum43 mm.

Length of hind tibia73–.75 mm.

Comparison with other species.—Differs from *N. thompsonae* and *N. microsoma* in the head not being clothed with microscopical hairs.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Queen.

Morphotype.—Soldier.

The description is based upon a single queen and numerous soldiers collected from two different colonies by the author at Kartabo.

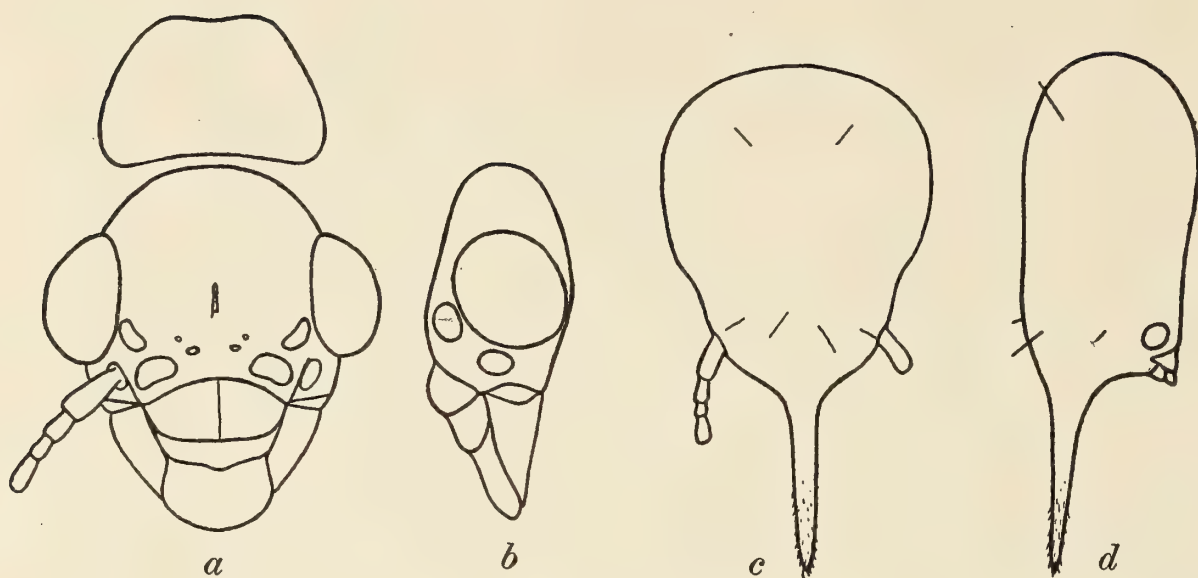


Fig. 67. *Nasutitermes* (*Subulitermes*) *osborni*, sp. nov. a, imago, dorsal view of head and pronotum; b, imago, lateral view of head; c, soldier, dorsal view of head; d, soldier, lateral view of head.

***Nasutitermes* (*Subulitermes*) *osborni*, sp. nov.**

(Fig. 67)

Imago (queen).—Head dark brown, oval. Fontanelle slit-shaped, about the same length as the ocelli. Muscle insertions rather plain.

The 3d segment of the antennae nearly equal to the 2d, the 4th longer than the 2d.

Eyes very large and very close to the lower margin of the head. Ocelli large, very close to the eyes.

Postclypeus conspicuously lighter than the head, median line distinct.

Pronotum lighter than the head; sides slightly rounded, anterior angles rather sharp, posterior margin nearly straight, somewhat concave.

Posterior margins of the meso- and metanota widely concave.

Abdominal tergites about the same color as the pronotum.

Measurements.—

Length of head	1.17 mm.
Width of head	1.07 mm.
Diameter of eye . . . . .	.43 mm.
Length of pronotum . . . . .	.57 mm.
Width of pronotum . . . . .	.83 mm.
Length of hind tibia	1.44 mm.
Length of queen	6.20 mm.

Comparison with other species.—A little larger than *N. oculatissimus* and the ocelli smaller. Eye very much larger than in *N. raripilus*.

Soldier.—Head yellow, egg-shaped from above, with a small constriction in back of the base of the antennae, profile convex with only a slight indentation

in the middle; 4 bristles at the base of the nose and 2 on the vertex, no small hairs visible.

Antennae with 12 segments, the 3d much smaller than the 2d, the 2d equal to the 4th. The 3d segment just dividing from the 4th. Mandibles with no point present.

Nose brown, long and slender, not turned up in profile; small hairs at the tip of the nose and along the outer end.

Thorax pale. Abdomen the color of the intestinal contents. Tergites with a marginal row of bristles and covered with very minute hairs.

Measurements.—

Total length.....	3.20–3.35 mm.
Length of head.....	1.30–1.33 mm.
Width of head.....	.63–.67 mm.
Length of antennae.....	1.27 mm.
Width of pronotum.....	.40–.41 mm.
Length of hind tibia.....	.67–.77 mm.

Comparison with other species.—Nose longer and proportionately more slender than in *N. oculatissimus*, elevation at the base of the nose not so conspicuous in profile. So close to *N. raripilus* that I have found no good character to distinguish them apart. *N. osborni* is generally a little smaller, but the largest specimens of *N. osborni* seem to be about the same as the smallest of *N. raripilus*.

Type locality.—Cow Island, British Guiana (Bartica District).

Range.—Known only from the type locality.

Holotype.—Queen.

Morphotype.—Soldier.

The description is based upon a single queen and numerous soldiers collected from a single colony by the author at Cow Island, about six miles from Kartabo, near Bartica.

I have named the species after Prof. Henry Fairfield Osborn, President of the New York Zoological Society, whose interest and encouragement has made possible the founding and the continuation of the Tropical Research Station of the Society at Kartabo.

***Nasutitermes (Subulitermes) snyderi*, sp. nov.**

(Fig. 68)

Imago.—Head dark brown, oval; covered with hair and a few bristles. Fontanelle slit-shaped and forked at the tip.

Antennae rather dark, with 14 segments, the 2d slightly larger than the 3d, the 3d about equal to the 4th.

Eyes rather large and prominent, close to the lower margin of the head. Ocelli proportionately rather large, less than $\frac{1}{2}$ their diameter from the eye.

Labrum light. Postclypeus nearly as dark as the head.

Pronotum nearly as dark as the head, hind margin not emarginate, sides and angles rounded.

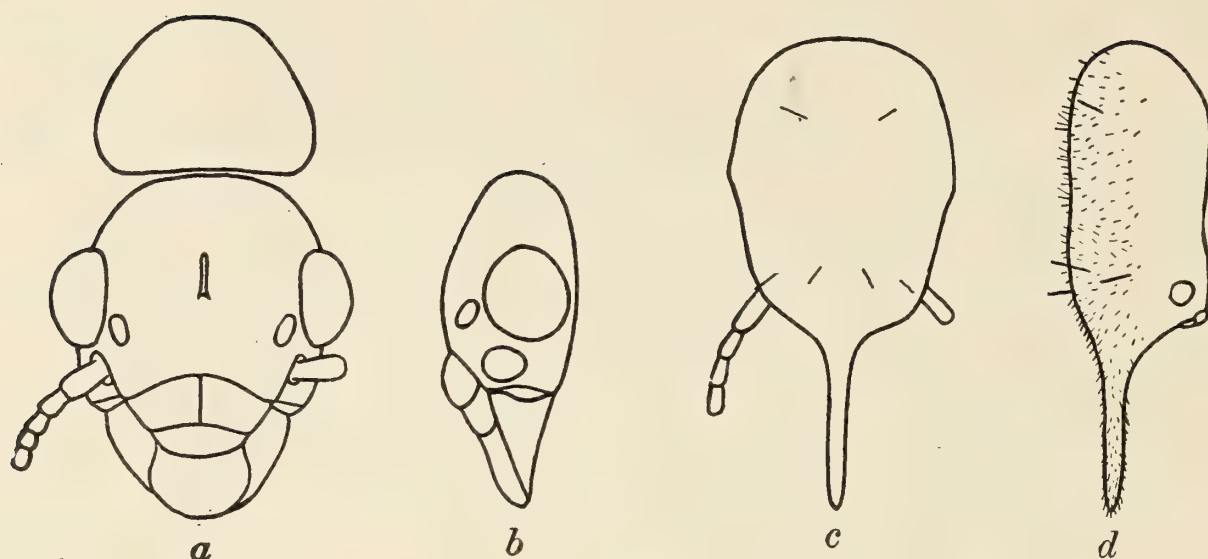


Fig. 68. *Nasutitermes* (*Subulitermes*) *snyderi*, sp. nov. *a*, imago, dorsal view of head and pronotum; *b*, imago, lateral view of head; *c*, soldier, dorsal view of head; *d*, soldier, lateral view of head.

Posterior margins of the meso- and metanota widely emarginate. Wings dark smoky, a light streak between the media and cubitus. Abdominal tergites about as dark as the pronotum.

Measurements.—

Length with wings	7.00–8.00 mm.
Length without wings	3.50–4.50 mm.
Length of head . . . . .	.76– .80 mm.
Width of head . . . . .	.67– .70 mm.
Length of antennae	1.33 mm.
Diameter of eye . . . . .	.23 mm.
Length of pronotum . . . . .	.37– .40 mm.
Width of pronotum . . . . .	.50– .53 mm.
Length of hind tibia . . . . .	.83 mm.
Length of anterior wing	6.56 mm.
Width of anterior wing	1.83 mm.

Soldier.—Head yellow, oval from above, with a very slight constriction behind the base of the antennae, profile from the base of the nose to the vertex roughly convex with a slight indentation in the middle; covered with small hairs and a few longer bristles at the base of the nose and on the vertex.

Antennae with 11 segments, the 2d, 3d, and 4th about equal.

Mandibles without sharp points.

Nose brownish yellow, straight and slender, covered with minute hairs.

Abdomen the color of the contents of the intestines; tergites with a row of marginal bristles and covered with fairly long hair.

Measurements.—

Total length	2.50–2.80 mm.
Length of head . . . . .	.90– .93 mm.
Width of head . . . . .	.40– .43 mm.

Measurements.—

Length of antennae . . . . .	.83– .87 mm.
Width of pronotum . . . . .	.30 mm.
Length of hind tibia . . . . .	.50– .53 mm.

Comparison with other species.—Seems to be fairly close to Banks' (1919) description of "*Constrictotermes*" *flaveolus*, but differs in being smaller and in having hairs all along the nose; also, the shape of the head is different.

Remarks.—Banks (1919) has placed similar species in *Constrictotermes* on account of the slight constriction. I am not of the opinion, however, that the constriction is of such fundamental importance as a subgeneric or generic character, especially in this group, where the constriction is often so slight that it is not easily distinguished. Certainly the differences between such species as *N. cavifrons* Holmgren and *N. snyderi* are very much more obvious than between *N. parvulus* and *N. snyderi*. The characters in the mandibles given by Holmgren seem to me to be of greater significance.

Type locality.—Kartabo, British Guiana.

Other locality.—Port of Spain, Trinidad.

Range.—British Guiana, Trinidad.

Holotype.—Winged imago.

Morphotype.—Soldier.

Described from numerous winged imagos and soldiers collected from two different colonies at Kartabo, and from numerous soldiers collected from a single colony by the author at Trinidad.

The species is named in honor of Dr. Thomas E. Snyder of the Bureau of Entomology in Washington, who has done such excellent work on the biology of the North American termites.

Subgenus *Convexitermes* Holmgren

This subgenus has formerly included only two species described by Holmgren (1906) from Peru. I was therefore somewhat surprised to find a series of four species at Kartabo including three new species. The other seems to conform with a species already described from Peru. This subgenus, as in the case of *Subulitermes*, is also composed of small, rather inconspicuous species, which the ordinary observer would not find. It is to be expected, therefore, that numerous other species of the group will be discovered when more careful work is done in South America.

Nasutitermes (*Convexitermes*) *nigricornis* (Holmgren).

Eutermes nigricornis Holmgren (1906), p. 600 (soldier, worker), *text-fig.* Y' (soldier), *text-fig.* Z' (worker).
Eutermes nigricornis Holmgren (1910), p. 218, 297 (soldier, worker), *text-fig.* 67 (soldier).

(Fig. 69)

Imago.—Head brown, not very dark, oval. Fontanelle slit-shaped. 4 muscle insertions in a curved row in front of the fontanelle and 2 large ones in front of the ocelli.

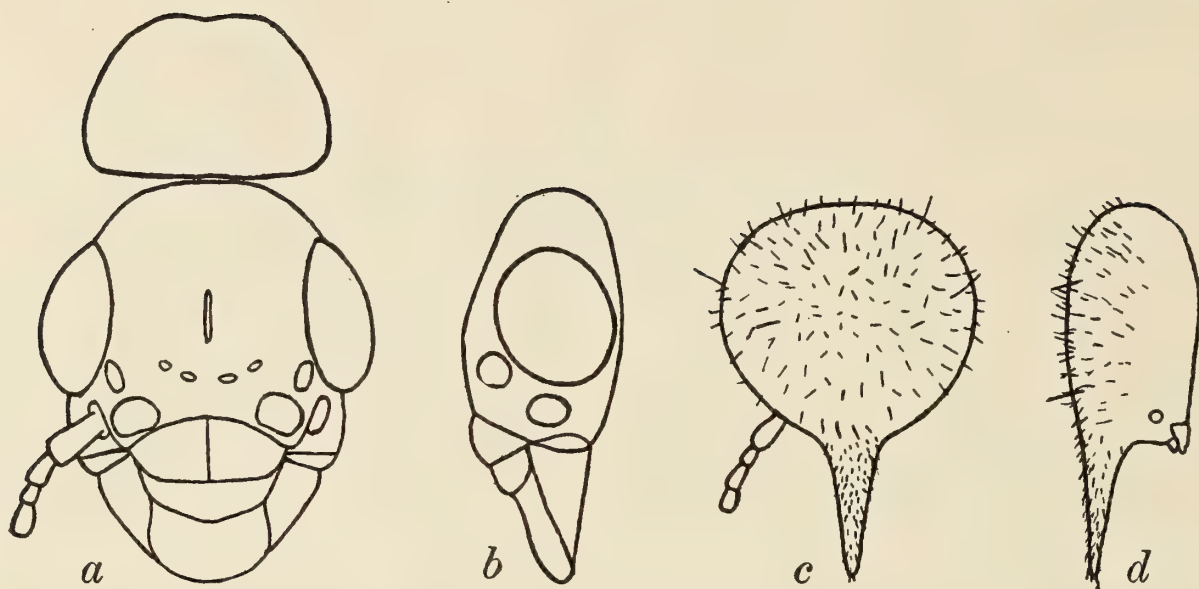


Fig. 69. *Nasutitermes* (*Convexitermes*) *nigricornis* (Holmgren). *a*, imago, dorsal view of head and pronotum; *b*, imago, lateral view of head; *c*, soldier, dorsal view of head; *d*, soldier, lateral view of head.

3d segment of the antennae very small, the 2d equals the 4th.

Eyes very large and very close to the lower margin of the head. Ocelli fairly large, much less than $\frac{1}{2}$ their width from the eyes.

Postclypeus brownish yellow, much lighter than the head, median line rather faint.

Pronotum lighter than the head, sides somewhat rounded, posterior margin slightly emarginate.

Posterior margins of meso- and metanota widely emarginate.

Abdominal tergites pale, lighter than the pronotum.

Measurements.—

Length of head	1.07 mm.
Width of head . . . . .	.87- .90 mm.
Diameter of eye . . . . .	.40 mm.
Length of pronotum . . . . .	.50 mm.
Width of pronotum . . . . .	.73- .76 mm.
Length of hind tibia	1.37-1.40 mm.
Length of queen	18.00 mm.
Width of abdomen of queen	4.00 mm.

Soldier.—Head yellow, round from above, profile convex; covered with fairly long hairs and a few long bristles.

Antennae with 11 segments, the 3d longer than the 4th, the 4th a little longer than the 2d.

Nose brownish, darker than the head, conical, thick at the base, but not nearly so much so as *N. kartaboensis*; covered with short hairs.

Pronotum pale. Abdomen the color of the intestinal contents. Tergites covered with long hair and the posterior margins with a row of bristles.

Measurements.—

Total length	3.50-3.70 mm.
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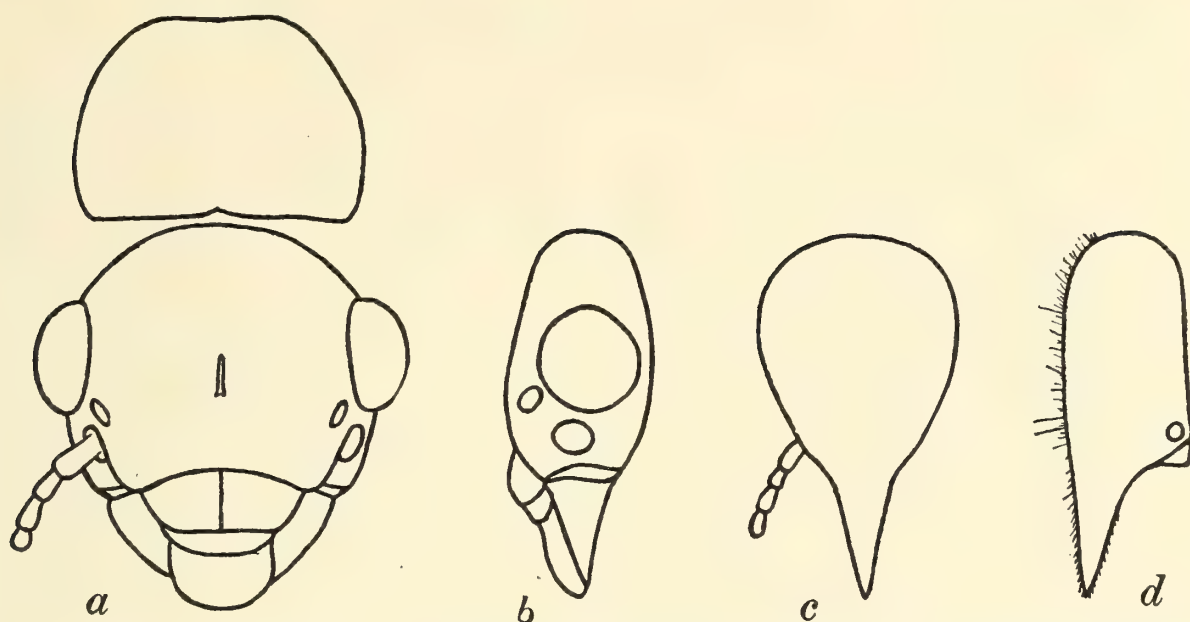


Fig. 70. *Nasutitermes* (*Convexitermes*) *kartaboensis*, sp. nov. *a*, imago, dorsal view of head and pronotum; *b*, imago, lateral view of head; *c*, soldier, dorsal view of head; *d*, soldier, lateral view of head.

Measurements.—

Length of head.....	1.25–1.35 mm.
Width of head.....	.80–.82 mm.
Length of antennae.....	1.16 mm.
Width of pronotum.....	.43 mm.
Length of hind tibia.....	.73–.77 mm.

Remarks.—Seems to conform with Holmgren's description in detail. The longer bristles on the head, however, stand out more than in Holmgren's figure.

Type locality.—Chaquimayo (Carabaya), Peru.

New locality.—Kartabo, British Guiana.

Range.—Peru, British Guiana.

The description is based upon a king and queen and many soldiers taken from two different colonies at Kartabo by the author.

***Nasutitermes* (*Convexitermes*) *kartaboensis*, sp. nov.**

(Fig. 70)

Imago.—Head dark brown, oval. Fontanelle slit-shaped and forked at the tip.

Antennae with 14 segments, the 2d equals the 3d, the 4th is shorter than the 3d.

Eyes fairly large and prominent, fairly close to the lower margin of the head. Ocelli of medium size, usually a little more than $\frac{1}{2}$ their width from the eyes.

Postclypeus slightly lighter than the head, median line faint or absent.

Pronotum slightly lighter than the head, sides somewhat rounded, posterior margin nearly straight, anterior angles fairly sharp.

Posterior margins of the meso- and metanota widely concave.

Wings smoky, conspicuously larger than in *N. mazaruniensis*.
Abdominal tergites about the same color as the pronotum.

Measurements.—

Length with wings	9.00–10.00 mm.
Length without wings	5.00– 6.00 mm.
Length of head	.93– .97 mm.
Width of head	.83– .85 mm.
Length of antennae	1.43– 1.47 mm.
Diameter of eye	.27– .29 mm.
Length of pronotum	.46– .47 mm.
Width of pronotum	.70– .73 mm.
Length of hind tibia	1.03– 1.07 mm.
Length of anterior wing	7.70– 7.87 mm.
Width of anterior wing	2.26– 2.33 mm.

Comparison with other species.—Pronotum slightly larger than in *N. mazaruniensis* and the wings conspicuously longer.

Soldier.—Head yellow, egg-shaped from above, with a very slight constriction in back of the base of the antennae, profile fairly straight or slightly convex; head covered with rather long hairs and a few longer bristles.

Antennae with 11 segments, the 2d equals the 4th, the 3d a little longer than the 2d.

Nose dark brown, contrasting more with the rest of the head than in *N. mazaruniensis*. Nose rather thick at the base, cone-shaped and covered with short hairs.

Pronotum pale. Abdomen the color of the intestinal contents. Tergites covered with rather long hairs and with a row of bristles on the posterior margins.

Measurements.—

Total length	3.30–3.50 mm.
Length of head	1.07 mm.
Width of head	.55– .57 mm.
Length of antennae	.93 mm.
Width of pronotum	.36 mm.
Length of hind tibia	.53– .57 mm.

Comparison with other species.—Close to *N. nigricornis*, but much smaller, and the head has a slight constriction which is not present in *N. nigricornis*. Very close to *N. mazaruniensis* and I have been unable to find any good character to separate the soldiers. Every case examined, however, showed that *N. kartaboensis* had a little darker nose than did *N. mazaruniensis*.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Winged imago.

Morphotype.—Soldier.

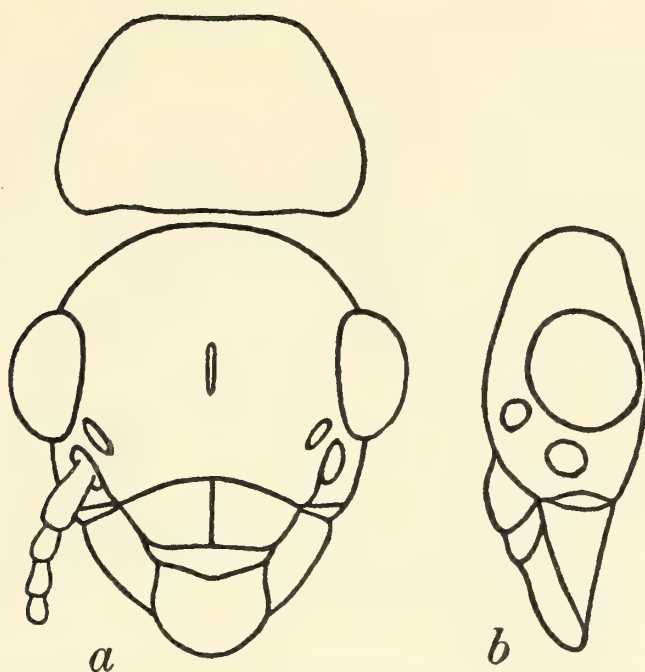


Fig. 71. *Nasutitermes (Convexitermes) mazaruniensis*, sp. nov. *a*, imago, dorsal view of head and pronotum; *b*, imago, lateral view of head.

The description is based upon many winged imagos and several soldiers from Kartabo collected by the author from three different colonies.

***Nasutitermes (Convexitermes) mazaruniensis*, sp. nov.**

(Fig. 71)

Imago.—Head dark brown, oval. Fontanelle slit-shaped, forked at the tip.

Antennae with 14 segments, the 3d equals the 2d, the 4th is shorter than the 3d.

Eyes fairly large and prominent, and fairly close to the lower margin of the head. Ocelli fairly large, less than $\frac{1}{2}$ their width from the eyes.

Postclypeus a little lighter than the head, median line faint.

Pronotum slightly lighter than the head, sides and posterior margins fairly straight, angles fairly sharp.

Posterior margins of the meso- and metanota widely concave.

Wings smoky. Abdominal tergites a little lighter than the head.

Measurements.—

Length with wings	6.95–7.20 mm.
Length without wings	5.50–6.00 mm.
Length of head . . . . .	.87–.97 mm.
Width of head . . . . .	.77–.85 mm.
Length of antennae	1.43 mm.
Diameter of eye . . . . .	.27–.29 mm.
Length of pronotum . . . . .	.41–.43 mm.

Measurements.—

Width of pronotum.....	.63- .68 mm.
Length of hind tibia.....	.93-1.06 mm.
Length of anterior wing.....	6.20-6.73 mm.
Width of anterior wing.....	1.80-1.83 mm.

Comparison with other species.—This species is very close to *N. kartaboensis*, but differs conspicuously in the length of the wings.

Soldier.—Head yellow, egg-shaped from above with a slight constriction at the base of the antennae, profile of head and nose nearly straight or slightly convex.

Antennae with 11 segments, the 2d equals the 4th, the 3d is slightly longer than the 2d.

Nose brownish, not contrasting as strongly with the head as in *N. kartaboensis*. Nose cone-shaped, rather thick at the base, covered with short hairs which are shorter than the rather long hairs on the head. Several longer bristles also on the head.

Thorax pale. Abdomen the color of the intestinal contents. Tergites covered with rather long hair and with a row of bristles on the posterior margins.

Measurements.—

Total length.....	3.30-3.50 mm.
Length of head.....	1.00-1.07 mm.
Width of head.....	.54- .57 mm.
Length of antennae.....	1.00 mm.
Width of pronotum.....	.33 mm.
Length of hind tibia.....	.56- .60 mm.

Comparison with other species.—Very close to *N. kartaboensis*, but the nose is not quite as dark.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Winged imago.

Morphotype.—Soldier.

The description is based upon several winged imagos, soldiers and a single king and queen collected from two different colonies by the author at Kartabo.

***Nasutitermes (Convexitermes) manni*, sp. nov.**

(Fig. 72)

Imago.—Head dark brown, oval. Fontanelle slit-shaped, longer than the ocelli, forked at the tip. Head clothed with hair and a few long bristles.

Antennae with 14 segments, the 4th a little larger than the 2d, 3d larger than the 4th.

Eyes fairly large, prominent, fairly close to the lower margin of the head. Ocelli fairly large, about $\frac{1}{2}$ their width removed from the eyes.

Postclypeus slightly lighter than head, median line faint.

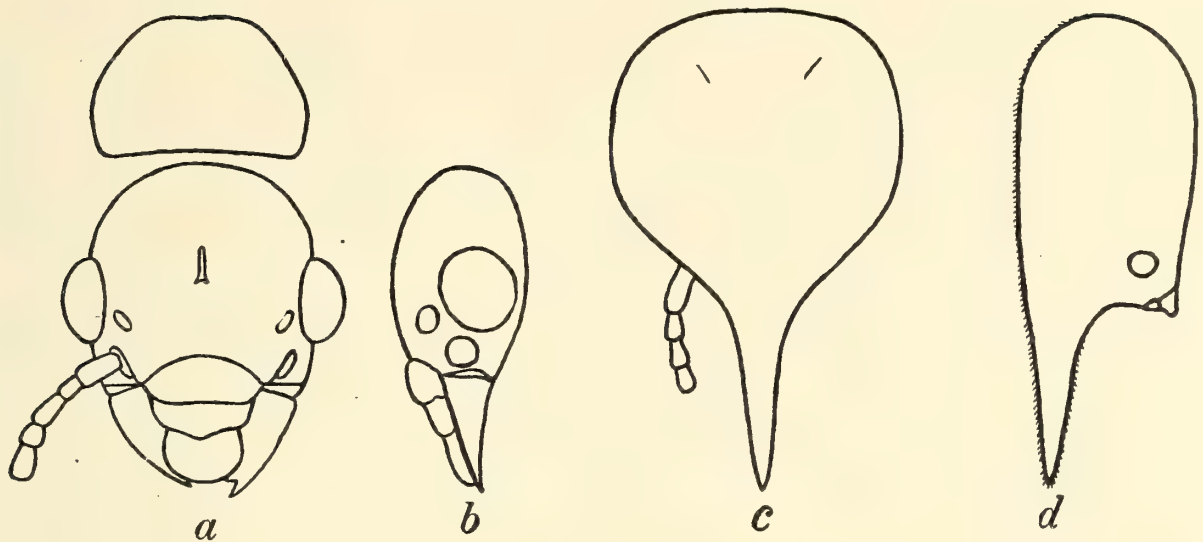


Fig. 72. *Nasutitermes (Convexitermes) manni*, sp. nov. *a*, imago, dorsal view of head and pronotum; *b*, imago, lateral view of head; *c*, soldier, dorsal view of head; *d*, soldier, lateral view of head.

Pronotum slightly lighter than head, posterior margins of meso- and metanota widely emarginate.

Wings smoky, a light streak between the media and cubitus, membrane covered with hairs and pigment spots.

Abdominal tergites about the same color as the pronotum.

Measurements.—

Length with wings	9.00–9.25 mm.
Length without wings	5.00–6.00 mm.
Length of head . . . . .	.93–1.00 mm.
Width of head . . . . .	.83–.87 mm.
Length of antennae	1.67–1.73 mm.
Diameter of eye . . . . .	.25–.27 mm.
Length of pronotum . . . . .	.43–.46 mm.
Width of pronotum . . . . .	.67–.74 mm.
Length of hind tibia	1.02–1.07 mm.
Length of anterior wing	6.83–7.50 mm.
Width of anterior wing	1.93–2.10 mm.

Soldier.—Head yellow, nearly round from above without the nose, posterior margin with a slight groove, profile convex. Head covered with very short hairs, 2 longer bristles on the vertex, bristles at the base of the nose either absent or present.

Antennae with 11 segments, the 3d a little longer than the 2d, the 4th about equal to the 2d.

Nose brown, darker than the head, covered with short hair, more slender than in *N. convexifrons*.

Pronotum pale, anterior margin emarginate.

Abdomen the color of the intestinal contents. Tergites covered with short hairs, no marginal bristles present.

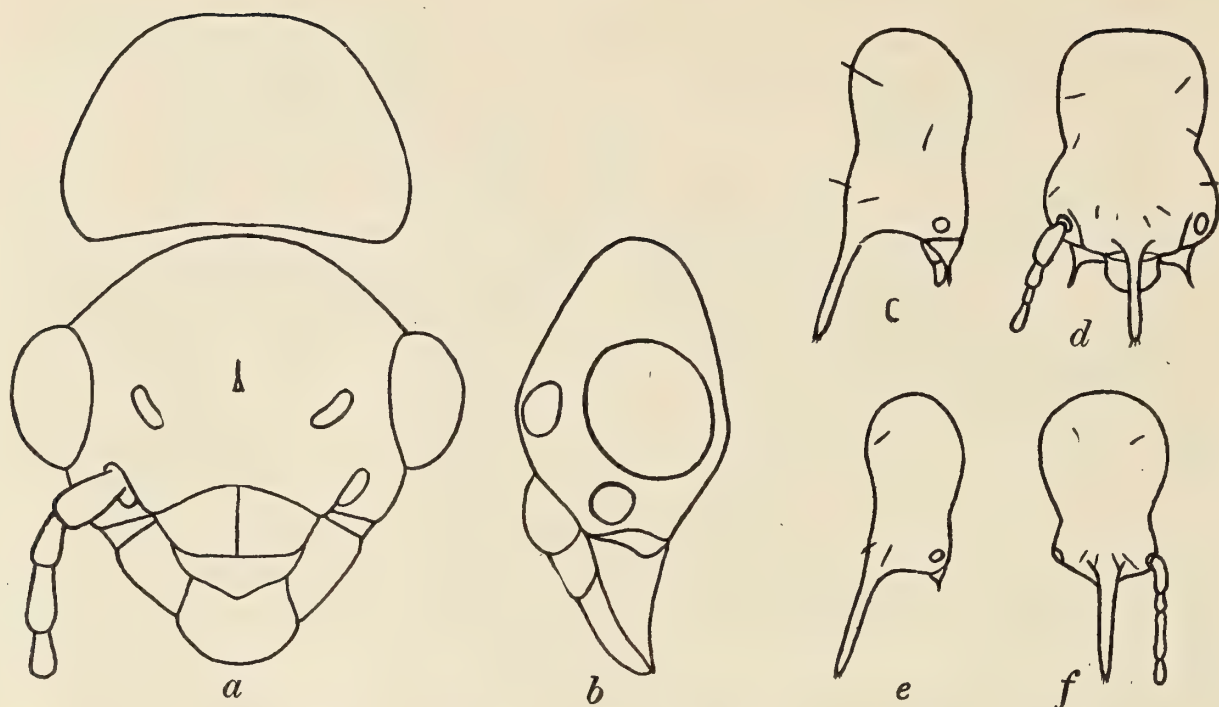


Fig. 73. *Nasutitermes* (*Velocitermes*) *beebei*, sp. nov. *a*, imago, dorsal view of head and pronotum; *b*, imago, lateral view of head; *c*, major soldier, lateral view of head; *d*, major soldier, dorsal view of head; *e*, minor soldier, lateral view of head; *f*, minor soldier, dorsal view of head.

Measurements.—

Total length.....	3.00–3.40 mm.
Length of head.....	1.27–1.53 mm.
Width of head.....	.77–.87 mm.
Length of antennae.....	1.03–1.10 mm.
Width of pronotum.....	.40–.45 mm.
Length of hind tibia.....	.67–.83 mm.

Comparison with other species.—The soldier is very close to *N. convexifrons* (Holmgren), but differs in having a more slender nose.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Soldier.

Morphotype.—Imago.

The description is based upon many soldiers and winged imagos taken from six different colonies by the author at Kartabo. I take pleasure in naming this species in honor of Wm. M. Mann of the U. S. National Museum, who has determined a large number of the termitophilous Coleoptera found at Kartabo.

Subgenus *Velocitermes* Holmgren

This interesting subgenus is known only from four species including the new species described below. All these species are confined to the Neotropical region and only one, *N. antillarum* (Holmgren) from Hispaniola, is to be found off the South American continent. The peculiar dimorphism among the

soldiers is very remarkable and as far as I know, nothing definite is yet known concerning the function of the different types.

A single rare species was found at Kartabo which proved to be new.

Nasutitermes (Velocitermes) beebei, sp. nov.

(Fig. 73)

Imago (male).—Head dark brown, oval, clothed with short hair and longer bristles. Fontanelle white, slit-shaped, not quite as long as the ocelli.

Antennae with 15 segments, 3d much longer than the 2d and slightly shorter than the 1st, 2d and 4th about equal.

Eye rather large, very prominent and close to the lower margin. Ocelli rather large, facing laterally, about their width removed from the eyes.

Postclypeus slightly lighter than the head, median line present.

Pronotum somewhat lighter than the head; proportionately rather long; posterior margin not or very imperceptibly emarginate; covered with hairs and bristles.

Wings smoky, a light streak between the media and cubitus. Membrane covered with short hairs and pigment spots.

Abdominal tergites same color as the pronotum.

Measurements.—

Length with wings	12.80 mm.
Length without wings	6.00 mm.
Length of head	1.37 mm.
Width of head	1.30 mm.
Diameter of eye . . . . .	.40 mm.
Length of pronotum . . . . .	.70 mm.
Width of pronotum	1.10 mm.
Length of hind tibia	1.83 mm.
Length of anterior wing	10.35 mm.
Width of anterior wing	3.06 mm.

Major soldier.—Head dark brown, larger and thicker than that of the minor soldier, widest in the region of the antennae, elevation at the base of the nose very conspicuous, posterior margin straighter than in the minor soldier; 4 bristles over the base of the nose, 2 on the vertex, 2 on the sides near the constriction and 2 on the cheeks; middle of head very conspicuously constricted.

Antennae about the same color as the head, with 14 segments, the 2d, 3d, and 4th equal in length but the 3d is not as thick as the 2d or 4th.

Mandibles distinct, relatively large, with sharp points.

Tip of nose lighter than the head; nose relatively shorter than the minor soldier, slender and slightly enlarged at the tip.

Pronotum with minute hairs and a few bristles on the anterior margin.

Abdominal tergites somewhat lighter than the head, with a row of bristles on the posterior margin, hair absent. Sternites with long hairs and bristles.

Measurements.—

Total length.....	4.00 mm.
Length of head.....	1.34–1.50 mm.
Width of head.....	.68–.73 mm.
Length of antennae.....	1.92–2.00 mm.
Width of pronotum.....	.60 mm.
Length of hind tibia.....	1.54–1.60 mm.

Minor soldier.—Head same color as major soldier, constricted in the middle, profile with a faint elevation at the base of the nose; with only a few bristles, 4 at the base of the nose and 2 on the vertex.

Antennae long, sometimes with 14 segments, but more often with 13. When with 13, the 3d is over double the length of the 2d and the tip is enlarged, the 4th is longer than the 2d. When with 14 segments, the 3d is about equal to the 2d and is without bristles.

Nose slender, fairly long, pointed up.

Pronotum with a raised anterior margin which is not emarginate; without bristles but covered with small, fine hairs.

Abdominal tergites with a row of bristles on the posterior margins, but no hairs are present.

Measurements.—

Total length.....	3.50–4.20 mm.
Length of head.....	1.25–1.50 mm.
Width of head.....	.57–.73 mm.
Length of antennae.....	2.40–2.67 mm.
Width of pronotum.....	.40–.47 mm.
Length of hind tibia.....	1.35–1.53 mm.

Comparison with other species.—Closest to *N. heteropterus* (Silvestri) but both castes of soldiers are quite distinct in shape and size.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Major soldier.

Morphotype.—Minor soldier and winged imago.

The description is based upon a single winged imago, several major soldiers and many minor soldiers collected from five different colonies by the author at Kartabo.

I have named the species in honor of Mr. William Beebe, the Director of the Tropical Research Station of the New York Zoological Society at Kartabo, to whom I owe the wonderful opportunity for spending twenty-four months at the station working upon the termites of the region.

Subgenus *Constrictotermes* Holmgren

This subgenus includes three species in the sense in which Holmgren (1912) defined the subgenus. I do not believe that any of the species included in the paper by Banks (1919) in *Constrictotermes* rightfully belong to this group.

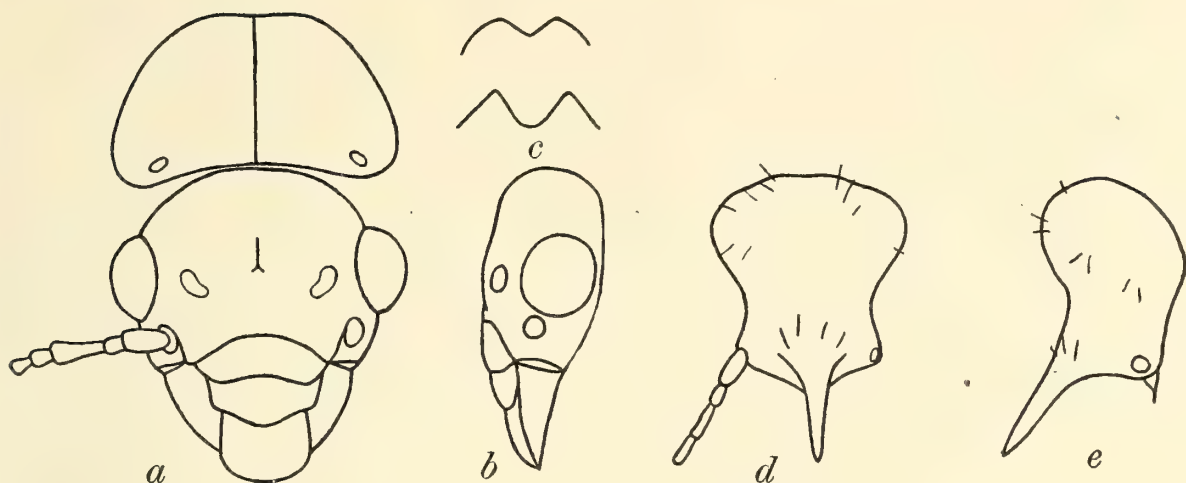


Fig. 74. *Nasutitermes* (*Constrictotermes*) *cavifrons* (Holmgren). *a*, imago, dorsal view of head and pronotum; *b*, imago, lateral view of head; *c*, imago, hind margins of thoracic nota; *d*, soldier, dorsal view of head; *e*, soldier, lateral view of head.

Without examining any of these species, I believe that most of them will fit into the subgenera *Subulitermes* or *Tenuirostritermes* as defined by Holmgren (1912).

The three species included in the subgenus *Constrictotermes* are, so far, known only from South America. One of these, which was described from Surinam, was found rather commonly in British Guiana.

Nasutitermes (*Constrictotermes*) *cavifrons* (Holmgren).

Eutermes (*Constrictotermes*) *cavifrons* Holmgren (1910), p. 318 (soldier, worker), text-fig. 78 (soldier).

Eutermes (*Constrictotermes*) *cavifrons* Holmgren (1912), pp. 65, 67, text-fig. 43 (mandibles of soldier).

(Fig. 74)

Imago.—Head brownish black, sparsely covered with fairly long hair; widely oval. Fontanelle slit-shaped, forked at the tip, as long as the ocelli.

Antennae lighter than the head, with 15 segments, the 2d equal to the 4th, the 3d more than double the length of the 2d.

Eyes large and prominent, close to the lower margin of the head. Ocelli large and prominent, about their own length removed from the eyes.

Labrum lighter than the head. Postclypeus brownish black, without distinct median line.

Pronotum lighter than the head, sparsely covered with fairly long hair; large, as wide as the head or nearly so, sides and angles rounded, posterior margin very faintly emarginate.

Posterior margins of meso- and metanota deeply emarginate.

Wings dark smoky, venation distinct.

Abdomen brownish black. Soft parts of the abdomen of the queen yellowish in life.

Measurements.—

Length with wings.....17.00–19.00 mm.

Length without wings..... 8.00–10.00 mm.

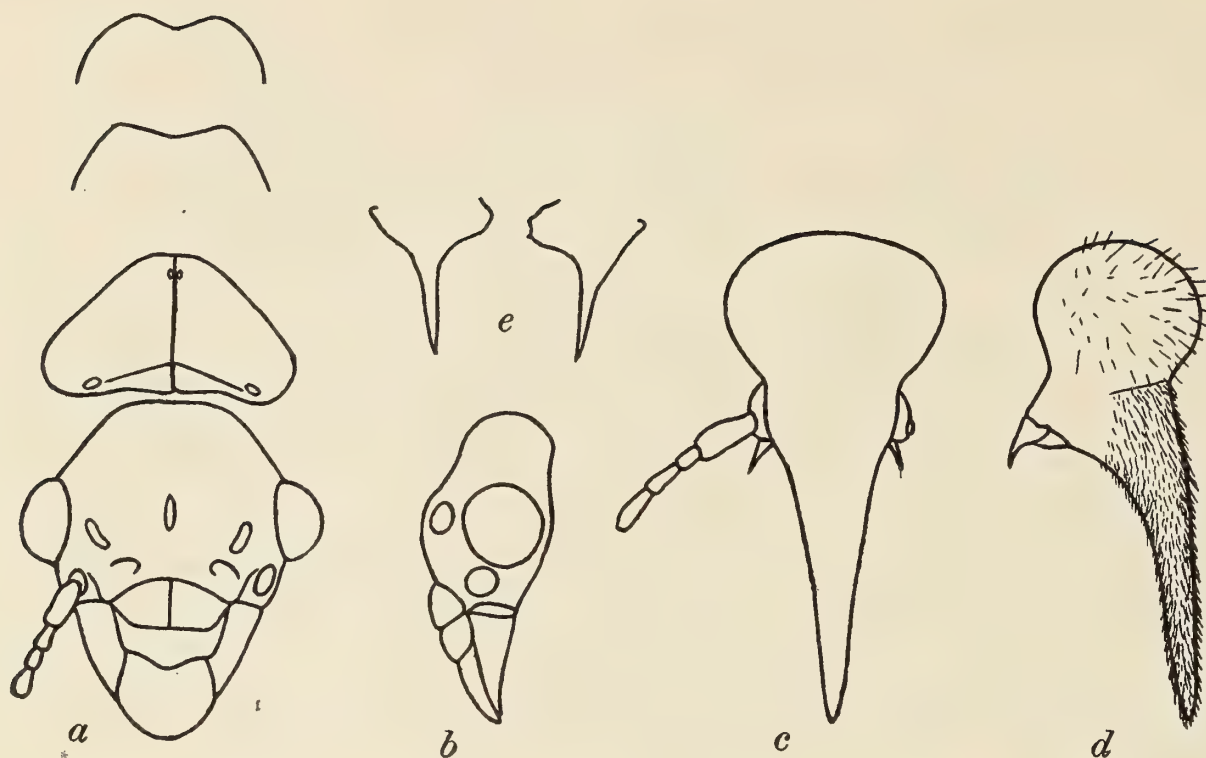


Fig. 75. *Nasutitermes* (*Angularitermes*) *nasutissimus*, sp. nov. a, imago, dorsal view of head, pronotum and margins of thoracal nota; b, imago, lateral view of head; c, soldier, dorsal view of head; d, soldier, lateral view of head; e, soldier, mandibles.

Measurements.—

Length of head.....	1.83– 1.90 mm.
Width of head.....	1.69– 1.83 mm.
Length of antennae.....	2.53– 2.57 mm.
Diameter of eye.....	.50– .53 mm.
Length of pronotum.....	1.00– 1.03 mm.
Width of pronotum.....	1.73– 1.83 mm.
Length of hind tibia.....	2.16– 2.43 mm.
Length of anterior wing.....	13.50–15.00 mm.
Width of anterior wing.....	3.76– 4.11 mm.
Length of queen.....	18.00 mm.
Width of abdomen of queen.....	4.20 mm.

Soldier.—Head brownish black, region around the antennae lighter; with a strong constriction in the middle; 4 bristles at the base of the nose and a number on the vertex.

Antennae with dark rings about the same color as the head, very long, with 15 segments, the 3d nearly double the length of the 2d, the 4th a little shorter than the 3d, the 5th equal to the 3d.

Nose pointing up, tip lighter than the head.

Thorax yellow. Pronotum covered with a few bristles, anterior margin with fine hairs.

Legs relatively very long. Coxae and tarsi yellow, femora and part of tibiae next to the femora darker.

Abdominal tergites brownish black, with numerous bristles and few hairs. Sternites yellow, covered with hair and also with marginal rows of bristles.

Measurements.—

Total length	5.00–5.50 mm.
Length of head	1.56–1.70 mm.
Width of head	1.00–1.12 mm.
Length of antennae	3.40–3.58 mm.
Width of pronotum . . . . .	.67–.70 mm.
Length of hind tibia	2.00–2.27 mm.

Type locality.—Surinam.

New localities.—British Guiana: Kartabo, Bartica, Dunoon.

Range.—Surinam, British Guiana.

The description is based upon many winged imagos, kings, queens, and soldiers collected from eight different nests by the author at Kartabo. Soldiers collected by Mr. G. E. Bodkin from a single colony at Bartica, and soldiers collected by F. M. Gaige from a single colony at Dunoon agree with the Kartabo specimens.

Subgenus **Angularitermes** subgen. nov.

A single species of *Nasutitermes* found at Kartabo obviously did not belong to any subgenus yet described and I have therefore referred it to a new subgenus, *Angularitermes*, named for the distinctly angular character of the head of the imago. The soldier differs from other subgenera in the tremendously large nose in proportion to the rest of the head and in the mandibles, the description of which follows. Every other species with which I am familiar which possesses long legs such as the members of the subgenera *Constrictotermes* and *Velocitermes*, etc., are able to run swiftly, but this species is slow in its habits.

Nasutitermes (Angularitermes) nasutissimus, sp. nov.

(Fig. 75)

Imago.—Head dark brown, sparsely clothed with long hairs; oval, posterior margin behind the eyes angular from above, profile with a conspicuous elevation above the eyes. Fontanelle oval, about the same length as the ocelli.

Antennae yellow brown, the 3d segment about the same length as the 2d, the 4th segment a little longer than the 3d.

Eyes large, close to the lower margin of the head. Ocelli relatively large, a little less than their own width removed from the eyes.

Labrum yellowish. Postclypeus somewhat lighter than the head, not quite as long as half its width, strongly arched, with median line.

Pronotum nearly as dark as the head, a light spot near each anterior angle, 2 light spots together in the middle near the posterior margin; subtriangular, angles rounded, sides straight, strongly converging toward the rear. Pronotum narrower than the head.

Meso- and metanota lighter than the pronotum, posterior margins widely emarginate.

Abdominal tergites about the same color as the pronotum.

Measurements.—

Length of head	1.50–1.60 mm.
Width of head	1.36–1.43 mm.
Diameter of eye . . . . .	.43 mm.
Length of pronotum . . . . .	.70–.73 mm.
Width of pronotum	1.20–1.26 mm.
Length of hind tibia	2.17 mm.
Length of queen	12.00 mm.
Width of abdomen of queen	3.00 mm.

Soldier.—Head yellow brown, constricted behind the antennae; thickly covered with bristles.

Antennae same color as the head, with 14 segments, the 3d one and one-half times the length of the 2d, the 4th equals the 3d or is very slightly longer.

Mandibles with long points, the left with a very small microscopical tooth near the base, the right without a tooth near the base.

Nose darker than the head, very thickly covered with short hairs from the constriction in the head to the tip; very large, long, and thick at the base. This is the most extreme case of the development of the nose among all the nasuate soldiers known to me.

Thorax brownish yellow. Pronotum with bristles on the margins; anterior margin also with small hairs, slightly emarginate.

Legs proportionately very long. Abdominal tergites brownish yellow, covered thickly with long bristles.

Measurements.—

Total length	6.00–6.50 mm.
Length of head	2.69–2.73 mm.
Width of head	1.00–1.10 mm.
Length of antennae	3.20–3.30 mm.
Width of pronotum . . . . .	.63–.73 mm.
Length of hind tibia	2.13–2.33 mm.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Soldier.

Morphotype.—King.

The description is based upon a single king and queen and many soldiers from two colonies at Kartabo collected by the author.

Genus *Anoplotermes* Fr. Muller

This genus has been divided into two subgenera, both of which are represented in British Guiana.

Subgenus *Anoplotermes*, s. str. Holmgren

For a long time it was supposed that this subgenus was confined to the

Nectropical region. Silvestri (1914), however, has referred a number of African species to *Anoplotermes*. Including the species described in this report, there are twenty-seven known species of the group, eleven species reported from Africa and seventeen species reported from the Neotropical region. Many of the species, however, have not been described accurately enough to permit determination. Where there are no soldiers to give us comparatively easy characters for determination, the imago should be described with the utmost care.

I found five distinct species which I refer to the subgenus *Anoplotermes* in British Guiana. One other species has been reported by Hagen (1858) from British Guiana, but this species, *Anoplotermes cingulatus* (Burmeister), was not described well enough by Hagen to permit determination with accuracy. The species described by Silvestri (1903) under this name does not agree with any of my specimens and I think it probable, due to the difficulty of recognizing imagos, that Hagen may have included two species under his one description. It may, therefore, be possible that I have the species referred to, but I believe that it will avoid confusion to give it another name. All the species at Kartabo seem to be new.

Silvestri (1903) describes a species under the name *Anoplotermes morio* (Latreille). I have already pointed out in my discussion of the synonymy of *Nasutitermes* (*Nasutitermes*) *costalis* (Holmgren) that Fabricius (1793) had already described a species under the name *Termes morio* which I doubtfully have placed in synonymy with *Coptotermes testaceus*. I have also placed *Termes morio* Latreille in synonymy with *Nasutitermes costalis* following Hagen (1858). Latreille's species, however, is rather doubtful. Whatever the synonymy is, however, Silvestri's species needs a new name and I suggest the name *Anoplotermes* (*Anoplotermes*) *meridianus* for it, with the following synonymy:

***Anoplotermes* (*Anoplotermes*) *meridianus*, nom. nov.**

Anoplotermes morio Silvestri (1901), p. 8 (imago).

Anoplotermes morio Silvestri (1903), p. 99, 100 (imago, worker), text-fig. 32 (wing), p. 142 (biology), pl. 5, figs. 225, 226 (imago), fig. 227 (worker).

Anoplotermes (*Anoplotermes*) *morio* Holmgren (1912), pp. 73, 74, text-fig. 46 (mandibles of imago).

***Anoplotermes* (*Anoplotermes*) *silvestrii*, sp. nov.**

(Fig. 76)

Imago.—Head brownish black, widely oval, posterior margin round; covered with hairs of varying length. Fontanelle very large, round, a little lighter than the head. 2 conspicuous muscle insertions in front of the ocelli.

Antennae with 15 segments, the 3d very slightly shorter or as long as the 4th, the 4th slightly shorter than the 2d.

Eyes rather small, not very prominent, about $\frac{1}{4}$ their diameter from the lower margin of the head. Ocelli prominent, about their own length from the eyes.

Labrum pale. Postclypeus a little lighter than the head, median line faint, nearly as long as $\frac{1}{2}$ their width.

Pronotum a little lighter than the head, sides rounded, posterior margin weakly emarginate.

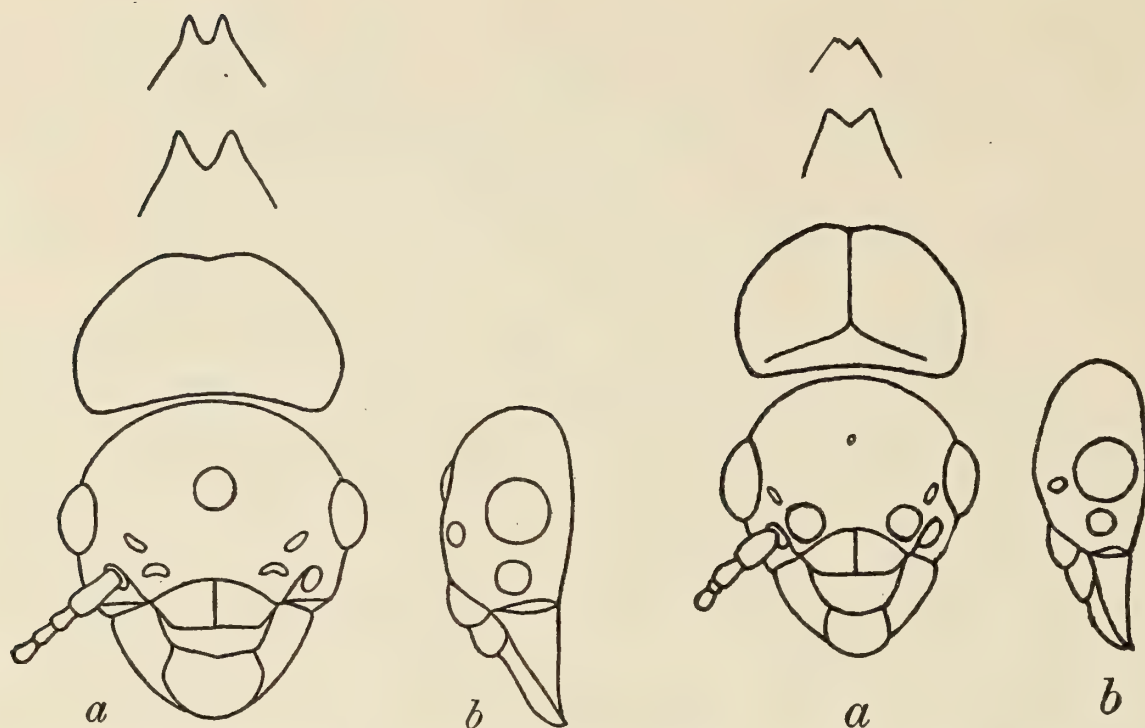


Fig. 76. *Anoplotermes* (*Anoplotermes*) *silvestrii*, sp. nov. *a*, imago, dorsal view of head, pronotum and margins of thoracic nota; *b*, imago, lateral view of head.

Fig. 77. *Anoplotermes* (*Anoplotermes*) *banksi*, sp. nov. *a*, imago, dorsal view of head; pronotum and margins of thoracic nota; *b*, imago, lateral view of head.

Posterior margins of meso- and metanota deeply emarginate, angles sharp, sides strongly converging.

Wings smoky, venation distinct throughout; with fine short hairs on the margins and veins, very few in the membrane of the wing.

Abdominal tergites a little lighter than the head.

Measurements.—

Length with wings.....	14.50–18.00 mm.
Length without wings.....	8.00–12.00 mm.
Length of head.....	1.55– 2.00 mm.
Width of head.....	1.44– 1.60 mm.
Length of antennae.....	2.36– 2.60 mm.
Diameter of eye.....	.36 mm.
Length of pronotum.....	.77– .87 mm.
Width of pronotum.....	1.33– 1.40 mm.
Length of hind tibia.....	2.00 mm.
Length of anterior wing.....	12.50–15.00 mm.
Width of anterior wing.....	2.90– 3.50 mm.
Length of queen.....	46.00 mm.
Width of abdomen of queen.....	7.00 mm.

Comparison with other species.—Close to *A. pacificus*, but it seems to have a larger fontanelle than indicated by Silvestri's (1903) figure. *A. turricola* differs in the size of the antennae segments and in the fontanelle.

Remarks.—Differs from Holmgren's characters of the subgenus in that

the 3d segment of the antennae is nearly as long as the 4th. The head of the worker, however, is light in color.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Winged imago.

The description is based upon many winged imagos, kings and queens collected from eight different colonies by the author at Kartabo. I take pleasure in naming this species after the distinguished Italian specialist, Prof. Filippo Silvestri, who has done so much to further our knowledge of termites from all parts of the world.

Anoplotermes (Anoplotermes) banksi, sp. nov.

(Fig. 77)

Imago.—Head dark brown, oval, thickly covered with rather long hairs. Fontanelle small and inconspicuous. 2 large muscle insertions in front of the ocelli.

Antennae with 15 segments, the 3d very minute, the 4th smaller than the 2d.

Eyes of medium size and not particularly close to the lower margin of the head. Ocelli rather small, their own length or slightly less removed from the eyes.

Postclypeus a little lighter than the head, median line present.

Pronotum a little lighter than the head, a Y-shaped mark in the middle, the stem of which is light and the branches of which are dark; sides rounded, posterior margin very slightly emarginate.

Posterior margins of the meso- and metanota narrow and deeply emarginate.

Wings light smoky in alcohol, veins indistinct near the apex. In some specimens the veins are more distinct and the area between the radius and media is reticulated. In life the wings have a bluish gray color.

Abdominal tergites about the same color as the pronotum.

Measurements.—

	Male	Female
Length with wings.....	8.00–8.50 mm.	9.50–10.00 mm.
Length without wings . . .	4.50–5.00 mm.	5.50– 6.00 mm.
Length of head.....	.90– .93 mm.	.97– 1.06 mm.
Width of head.....	.77– .83 mm.	.82– .90 mm.
Length of antennae.....	1.33–1.36 mm.	1.40– 1.50 mm.
Diameter of eye.....	.20– .21 mm.	.23 mm.
Length of pronotum.....	.43– .46 mm.	.46– .48 mm.
Width of pronotum.....	.60– .70 mm.	.71– .73 mm.
Length of hind tibia.....	.83– .97 mm.	.91– .94 mm.
Length of anterior wing..	7.00–7.26 mm.	7.95– 8.00 mm.
Width of anterior wing...	1.67–1.73 mm.	1.90– 1.95 mm.
Length of queen.....		25.00 mm.

Comparison with other species.—Close to *A. ater* Hagen, but the measurements are smaller.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Winged imago.

The description is based upon many winged imagos, kings and queens taken by the author from eight different colonies at Kartabo. The species is named in honor of Mr. Nathan Banks, the distinguished American entomologist, who has done so much valuable work upon the termites of the Nearctic and Neotropical regions.

Anoplotermes (Anoplotermes) brevipilus, sp. nov.

(Fig. 78)

Imago.—Head dark brown, oval, hair somewhat shorter than in *A. banksi*. Fontanelle small and inconspicuous.

Antennae with 15 segments, the 3d minute, the 4th shorter than the 2d.

Eyes of medium size, not very close to the lower margin of the head.

Ocelli fairly large, a little less than their width removed from the eyes.

Postclypeus a little lighter than the head, no median line visible.

Pronotum a little lighter than the head, crescent-shaped, light marks in the middle faint; posterior margin and sides form an even curve, anterior margin concave.

Posterior margins of the meso- and metanota narrowly and deeply emarginate.

Wings light smoky in color in alcohol. Abdominal tergites the same color as the pronotum.

Measurements.—

	Male	Female
Length with wings.....	7.00–7.40 mm.	8.25–8.50 mm.
Length without wings . . .	4.20–4.75 mm.	5.00–5.80 mm.
Length of head.....	.76– .80 mm.	.83– .85 mm.
Width of head.....	.68– .73 mm.	.70– .77 mm.
Length of antennae	1.07–1.10 mm.	1.10–1.25 mm.
Diameter of eye.....	.20 mm.	.22– .23 mm.
Length of pronotum.....	.33– .36 mm.	.36– .40 mm.
Width of pronotum.....	.53– .56 mm.	.57– .60 mm.
Length of hind tibia . . . . .	.63– .67 mm.	.70– .73 mm.
Length of anterior wing . .	5.70–5.95 mm.	6.82–7.00 mm.
Width of anterior wing . .	1.43–1.50 mm.	1.63–1.73 mm.

Comparison with other species.—Close to *A. banksi*, but smaller, and hair on head, pronotum and sternites somewhat shorter. The figure of the pronotum of *A. schwarzi* Banks (1919) is inaccurate. *A. schwarzi* is 14.00 mm. long and the width of the head is 1.30 mm. The specimens described as *A. fumosus* (Hagen) by Banks have larger mandibles and the antennae segments differ in the figure (Banks & Snyder, 1920). Hagen's (1860a) original description of *A. fumosus* gives the length with wings as 14.00 mm.

Type locality.—Kartabo, British Guiana.

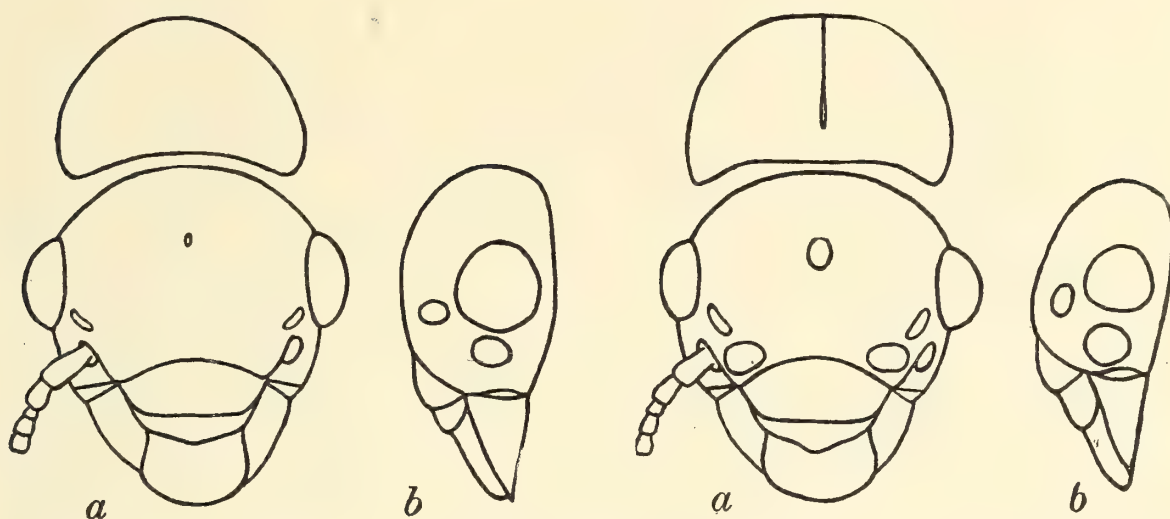


Fig. 78. *Anoplotermes (Anoplotermes) brevipilus*, sp. nov. *a*, imago, dorsal view of head and pronotum; *b*, imago, lateral view of head.

Fig. 79. *Anoplotermes (Anoplotermes) subterraneus*, sp. nov. *a*, imago, dorsal view of head and pronotum; *b*, imago, lateral view of head.

Range.—Known only from the type locality.

Holotype.—Winged imago.

The description is based upon many winged imagos, kings and queens taken from eleven different colonies by the author at Kartabo.

***Anoplotermes (Anoplotermes) subterraneus*, sp. nov.**

(Fig. 79)

Imago.—Head dark brown, widely oval, covered with medium long hair; 2 large muscle insertions in front of the ocelli. Fontanelle about the same size as the ocelli, white and conspicuous.

Antennae with 15 segments, the 3d small, the 4th shorter than the 2d.

Eyes of medium size, not very close to the lower margin. Ocelli rather large, less than their width from the eyes.

Postclypeus lighter than the head, no median line visible.

Pronotum lighter than the head, posterior margin and sides forming nearly an even curve, anterior angles sharp; a light line in the middle of the pronotum.

Posterior margins of the meso- and metanota narrowly and deeply emarginate.

Wings smoky, veins fairly distinct throughout.

Abdominal tergites same color as the pronotum, a light spot on the anterior border on each side.

Measurements.—

Length with wings.....	9.50–10.50 mm.
Length without wings.....	4.50– 6.20 mm.
Length of head.....	.97 mm.
Width of head.....	.83– .87 mm.
Length of antennae.....	1.43– 1.50 mm.
Diameter of eye.....	.23 mm.
Length of pronotum.....	.41– .46 mm.

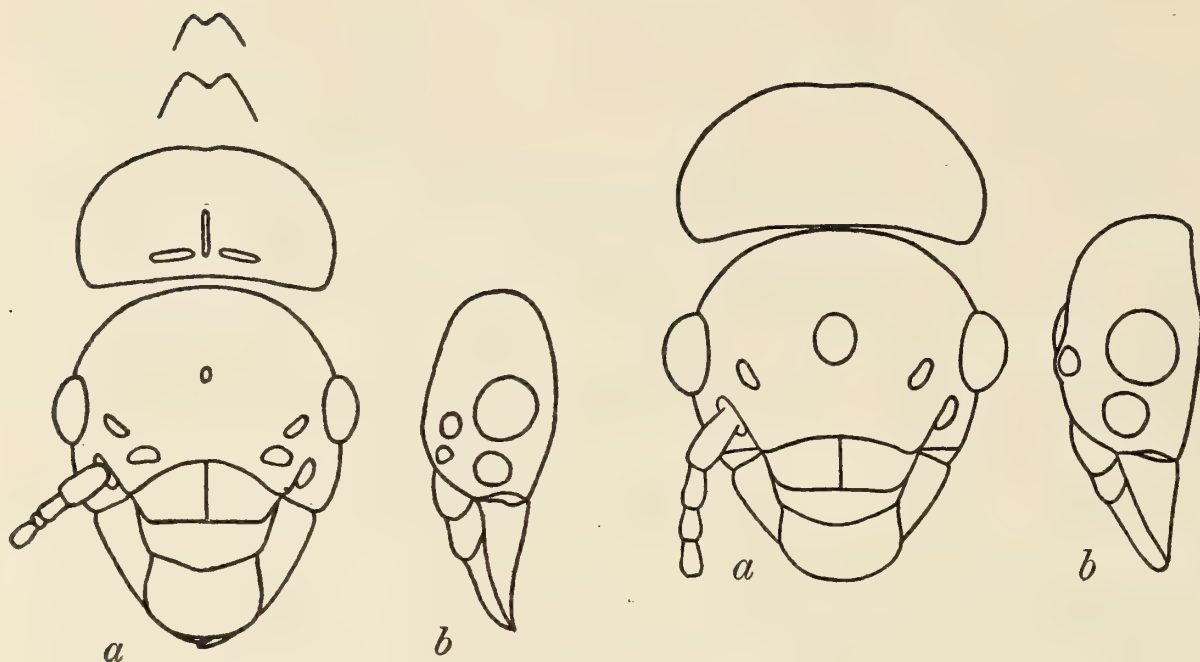


Fig. 80. *Anoplotermes* (*Anoplotermes*) *nigripunctatus*, sp. nov. *a*, imago, dorsal view of head, pronotum and margins of thoracic notae; *b*, imago, lateral view of head.

Fig. 81. *Anoplotermes* (*Speculitermes*) *arboreus*, sp. nov. *a*, imago, dorsal view of head and pronotum; *b*, imago lateral view of head.

Measurements

Width of pronotum.....	.67— .73 mm.
Length of hind tibia.....	.76— .80 mm.
Length of anterior wing.....	7.17— 8.40 mm.
Width of anterior wing.....	2.00— 2.18 mm.

Comparison with other species.—*A. ater* a little larger and without the conspicuous fontanelle. *A. banksi*, *A. brevipilus*, *A. schwarzi*, and *A. fumosus* all without the conspicuous fontanelle.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Winged imago.

Described from many winged imagos taken from a single colony by the author at Kartabo.

Anoplotermes (*Anoplotermes*) *nigripunctatus*, sp. nov.

(Fig. 80)

Imago (queen).—Head dark brown, oval. Fontanelle darker than the head, easily visible but small. Two muscle insertions in front of the ocelli.

Antennae light colored, the 3d segment small, the 4th shorter than the 2d.

Eyes rather small, not very close to the lower margin of the head. Ocelli of medium size, about their own length removed from the eyes.

Postclypeus a little lighter than the head, median line very faint.

Pronotum nearly as dark as the head, a T-shaped series of light marks in the center; sides and posterior margin nearly make a perfect curve.

Posterior margins of meso- and metanota narrowly and deeply emarginate.

Abdominal tergites about the same color as the pronotum, 2 light spots on the anterior margins.

Measurements.—

Length of head.....	1.25–1.33 mm.
Width of head.....	1.06–1.16 mm.
Diameter of eye.....	.28 mm.
Length of pronotum.....	.57–.58 mm.
Width of pronotum.....	.90–1.00 mm.
Length of hind tibia.....	1.30 mm.
Length of queen.....	40.00 mm.
Width of abdomen of queen.....	6.00 mm.

Comparison with other species.—Close to *A. meridianus*, but Silvestri's figure shows the posterior margin of the pronotum somewhat emarginate. Hagen's (1858) description of *A. tenebrosus* states that the fontanelle is yellowish.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Queen.

The description is based upon a single king and three queens collected from three different colonies by the author at Kartabo.

Subgenus *Speculitermes* Wasmann

Including the new species described in this report, 3 species have been referred to this subgenus, the genotype from India and Ceylon, the others from South America.

Anoplotermes (*Speculitermes*) arboreus, sp. nov.

(Fig. 81)

Imago.—Head black brown, oval, with rather short hair and longer bristles. Fontanelle same color as the head, large and round, similar to that of *A. silvestrii*.

Antennae with the 2d segment a little longer than the 3d, the 3d equal to the 4th.

Eyes of medium size, not close to the lower margin.

Ocelli rather large, prominent, about their own width removed from the eyes.

Postclypeus black brown, median line faint or absent.

Pronotum black brown, sides rounded, posterior margin somewhat emarginate.

Sides of meso- and metanota with a white border, posterior margins narrow and deeply emarginate.

Coxae and femora dark brown, most of tibiae of the prothoracic legs dark, rest yellow; most of tibiae of the meso- and metathoracic legs yellow and tarsi yellow.

Abdominal tergites black brown.

Measurements.—

Length of head.....	1.83 mm.
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Measurements.—

Width of head	1.67 mm.
Diameter of eye43 mm.
Length of pronotum90 mm.
Width of pronotum	1.61 mm.
Length of hind tibia	2.30 mm.
Length of queen	19.00 mm.
Width of abdomen of queen	4.80 mm.

Comparison with other species.—Silvestri (1903) described *A. reconditus* with a small oval fontanelle, while Holmgren (1906) described the fontanelle as slit-shaped. I think it likely that Holmgren's species from Bolivia and Peru is distinct from Silvestri's (1903) species from Argentina, Paraguay, and the Matto Grosso. However, the species from Kartabo seems to be distinct from them both.

Remarks.—As the name signifies, this species was the only *Anoplotermes* found nesting more than a few feet from the ground. The head of the worker is dark, thus distinguishing this species from all the others found in British Guiana.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Queen.

The description is based upon a single queen taken from a colony by the author at Kartabo. The species is evidently rather rare at Kartabo, because only three colonies were found. The nest was very different from all other nests in the vicinity and, being conspicuous, would have been seen if there had been many.

Genus *Cylindrotermes* Holmgren

This genus is known only by a single species from South America. Formerly it had only been reported from Bolivia. The specimens from British Guiana, however, seem to coincide with the description of the Bolivian species, so the range is doubtless rather extensive

Cylindrotermes nordenskiöldi Holmgren.

Cylindrotermes nordenskiöldi Holmgren (1906), p. 543 (soldier, worker), text-fig. G (soldier), text-fig. H (worker).

Cylindrotermes nordenskiöldi Holmgren (1912), p. 86, text-fig. 55 (soldier), pl. 4, fig. 21 (soldier).

(Fig. 82)

Imago.—Head medium dark brown, stippled with white, oval, arched between the eyes; covered with thick short hair and numerous bristles. Fontanelle small, round, a little lighter than the head. Muscle insertions not very distinct.

Eyes of medium size, not very close to the lower margin. Ocelli of medium size, about their width removed from the eyes.

Labrum yellowish. Postclypeus somewhat lighter than the forehead,

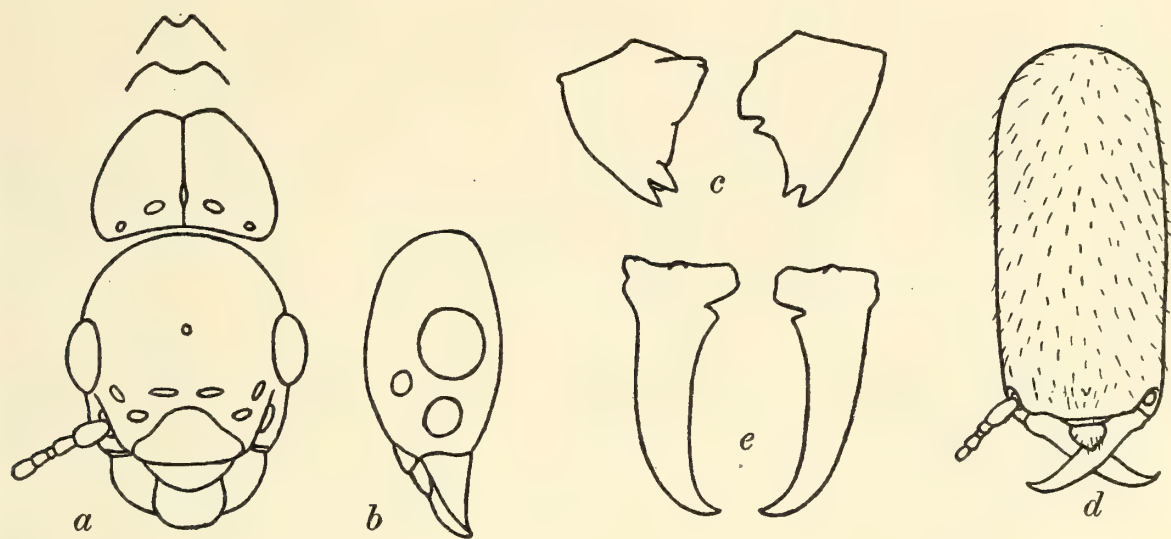


Fig. 82. *Cylindrotermes nordenskioldi* Holmgren. *a*, imago, dorsal view of head, pronotum and margins of thoracic nota; *b*, imago, lateral view of head; *c*, imago mandibles; *d*, soldier, dorsal view of head; *e* soldier, mandibles.

median line not visible. Suture between the forehead and the postclypeus very faint.

Mandibles as in the figure.

Pronotum slightly lighter than the head, with a Y-shaped series of light marks in the center; long and narrow, sides rounded and somewhat depressed, posterior margin deeply emarginate.

Posterior margins of the meso- and metanota emarginate.

All tibiae with 3 apical spines.

Wings smoky, veins distinct, media close to the cubitus with 2-4 branches, cubitus with 9-12 branches.

Abdominal tergites a little lighter than the head.

Measurements.—

Length with wings.....	7.50- 8.00 mm.
Length without wings.....	5.00- 5.30 mm.
Length of head.....	.96- 1.00 mm.
Width of head.....	.86- .87 mm.
Length of antennae.....	1.27- 1.30 mm.
Diameter of eye.....	.27 mm.
Length of pronotum.....	.43- .45 mm.
Width of pronotum.....	.60- .63 mm.
Length of hind tibia.....	.73 mm.
Length of anterior wing.....	6.54 mm.
Width of anterior wing.....	1.30 mm.
Length of queen.....	10.00 mm.
Width of abdomen of queen.....	1.50 mm.

Soldier.—Head yellow, front a little darker, covered with short bristles; very long, sides parallel, posterior margin rounded.

Antennae with 11 segments, the 3d sometimes showing a tendency to divide.

Mandibles red brown, short and curved, ends sharp, a single tooth near the base, left and right very similar.

Frontal gland opening present, very small, situated between the bases of the antennae.

Pronotum yellow, covered with short bristles; anterior lobe distinct, weakly emarginate in the middle.

Legs pale yellow, front tibiae with 3 apical spines, rest of tibiae with 2 apical spines.

Abdomen pale yellow. Tergites covered with short hairs and numerous longer bristles.

Measurements.—

Total length	3.46–4.40 mm.
Length of head with mandibles	2.01–2.33 mm.
Width of head . . . . .	.77–.87 mm.
Length of antennae . . . . .	.90–1.03 mm.
Length of pronotum . . . . .	.32–.40 mm.
Width of pronotum . . . . .	.57–.61 mm.
Length of hind tibia . . . . .	.57–.63 mm.
Length of left mandible . . . . .	.65–.75 mm.

Type locality.—Tuiche (Prov. Caupolican), Bolivia.

New locality.—Kartabo, British Guiana.

Range.—Bolivia, British Guiana.

The description is based upon several winged imagoes, a single queen, and numerous soldiers collected by the author from four different colonies at Kartabo.

Genus *Amitermes* Silvestri

Silvestri (1903, p. 217) changed the spelling which he originally used (1901) to *Hamitermes*. Silvestri, Holmgren, and Mjöberg have continued to use the later spelling because hook in Latin is spelled hamus. Banks (Banks & Snyder, 1920) went back to the original spelling and I have followed the international code rule in this respect.

This genus now contains six subgenera, *Euhamitermes*, known from two species from the Oriental Region, *Drepanotermes*, known from five species from Australia, *Monodontermes*, known from three species from Australia, *Synhamitermes*, known from three species, two of which are found in Ceylon and India and one known from the southern part of South America, *Globitermes*, known from three species all confined to the Oriental region, and *Amitermes*, s. str., which is discussed below. Altogether there are seventy-three species described from the genus from nearly all the warm parts of the world.

Subgenus *Amitermes*, s. str. Holmgren

This subgenus is by far the largest of all the subgenera of the genus *Amitermes*. I have fifty-seven species listed in the group distributed as follows: Africa twenty-six, Australia fifteen, Nearctic region six, Neotropical region five, Oriental region two, Palearctic region three. The subgenus has been able

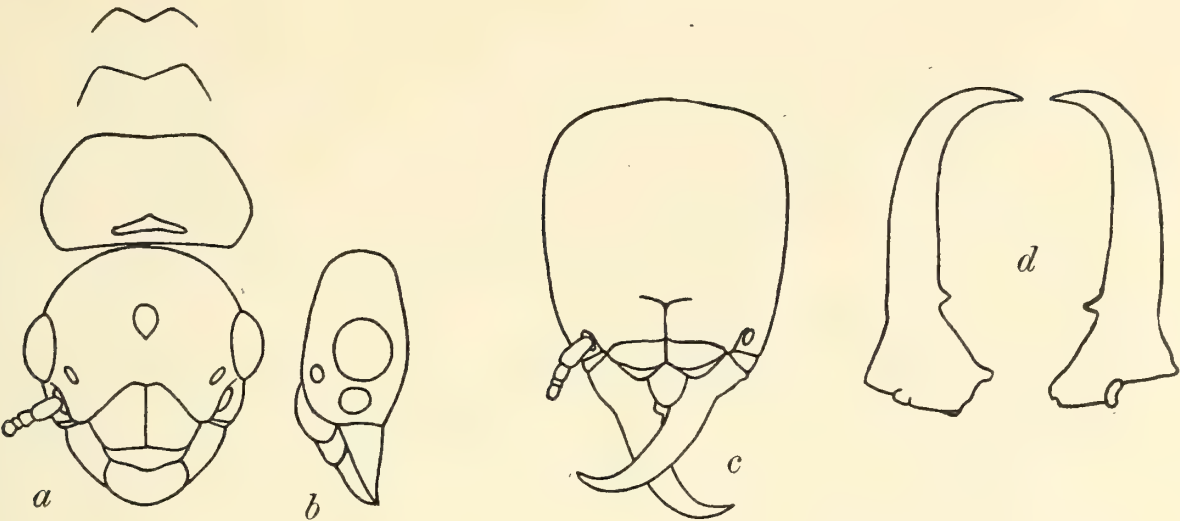


Fig. 83. *Amitermes (Amitermes) excellens* Silvestri. *a*, imago, dorsal view of head, pronotum and margins of thoracal nota; *b*, imago, lateral view of head; *c* soldier, dorsal view of head; *d*, soldier, mandibles.

to work its way very successfully into the temperate regions, the southern United States and northern Africa being well represented in number of species.

Only one species of this group was found in British Guiana. This species was recently described by Silvestri (1923).

Amitermes (Amitermes) excellens Silvestri.

Hamitermes excellens Silvestri (1923), p. 309 (imago, soldier, worker), pl. XII (imago, soldier).

(Fig. 83)

Imago.—Head brownish black, oval, thickly covered with short hair and a few long bristles. Fontanelle large, conspicuous, yellow, pointed in front.

Antennae light brown, with 15 segments, the 3d shorter than the 2d or 4th.

Eyes of medium size, rather prominent, not very close to the lower margin of the head. Ocelli of medium size, about their own length removed from the eyes.

Labrum yellowish brown. Postclypeus brown, very long, conspicuously arched, with median line.

Pronotum brownish black, a light curved mark near the anterior border; rather wide, wider than the head without the eyes, sides depressed, posterior margin somewhat emarginate.

Posterior margins of the meso- and metanota widely emarginate.

Wings dark smoky, media and outer portion of the cubitus indistinct, a light streak between the media and cubitus near the base.

Abdominal tergites dark brown.

Measurements.—

Length with wings.....	11.50–13.50 mm.
Length without wings.....	7.50– 8.50 mm.
Length of head.....	1.60– 1.71 mm.
Width of head.....	1.40– 1.43 mm.
Length of antennae.....	1.71– 1.73 mm.

Measurements.—

Diameter of eye . . . . .	.37 mm.
Length of pronotum . . . . .	.73– .75 mm.
Width of pronotum	1.25– 1.27 mm.
Length of hind tibia	1.50 mm.
Length of anterior wing	9.86 mm.
Width of anterior wing	2.78 mm.

Soldier.—Head yellow, with a few sparsely scattered long bristles; $1\frac{1}{2}$ times as long as broad, sides rounded.

Antennae yellow, with 14–15 segments.

Labrum rounded at the tip. Mandibles strong, similar to each other, each with a small tooth near the base, ends strongly curved and pointed. Gland opening near the front. Clypeus with a median line.

Pronotum yellow, sparsely covered with bristles; anterior lobe large and raised, anterior margin of lobe rounded.

Abdomen the color of the intestinal contents; tergites covered with bristles and short hair.

Measurements.—

Total length	5.00–7.00 mm.
Length of head	3.06–3.10 mm.
Width of head	1.65–1.70 mm.
Length of antennae	2.14–2.17 mm.
Width of pronotum . . . . .	.86– .90 mm.
Length of hind tibia	1.18–1.37 mm.
Length of left mandible	1.18–1.27 mm.

Type locality.—British Guiana: Kartabo.

Range.—Known only from British Guiana.

Localities.—British Guiana: Kartabo, Potaro.

The description is based upon many winged imagos and soldiers collected from four different colonies by the author at Kartabo. The imago described by Silvestri came from the same colony as the imagos described in this report.

Genus *Mirotermes* Wasmann

This genus has been divided into several subgenera and genera by various authors recently and I, myself, believe that many of the groups deserve generic rank. However, no one has treated the genus as a whole since Holmgren (1912) and I am convinced that it will cause less confusion to follow his general plan until further careful study has been made of the group as a whole. In the wide sense, the genus may be divided into thirteen groups including the new subgenera described in this report. These groups, which I am calling subgenera for the present, are as follows: *Euchilotermes* includes one species and two varieties from Africa; *Cubitermes* includes thirty-five species only recorded from Africa; *Procubitermes* includes twelve species from Africa; *Basidentitermes* includes eight species from Africa; *Orthotermes* includes a single species from Africa; *Ceratotermes* includes a single species from Africa; *Protocapritermes* includes a single species from Australia; *Tuberculitermes* includes a single species

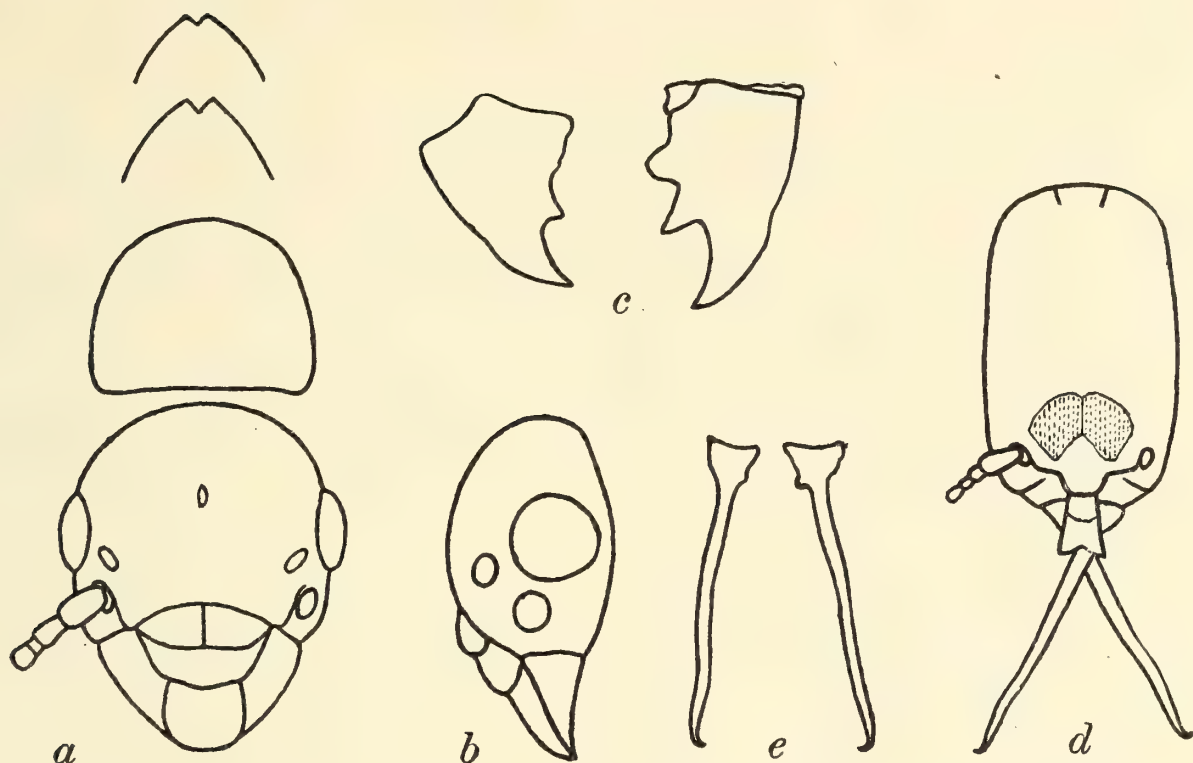


Fig. 84. *Mirotermes* (*Crepititermes*) *verruculosus*, sp. nov. *a*, imago, dorsal view of head, pronotum and margins of thoracic nota; *b*, imago, lateral view of head; *c*, imago, mandibles; *d*, soldier, dorsal view of head; *e*, soldier, mandibles.

from Africa; *Promirotermes* includes four species from Africa; and *Mirotermes*, s. str., *Spinitermes*, *Crepititermes*, and *Cavitermes* which will be discussed below. Altogether I have 106 species in my catalogue for the entire genus, distributed widely. All the subgenera with the exception of *Mirotermes*, s. str., however, are each confined to one region in their distribution.

Subgenus **Crepititermes**, subgen. nov.

This diminutive termite does not fit into any of the existing groups of the genus, so I have given it a new name. The soldier is quite distinct from all the other groups of the genus *Mirotermes* in that it has a flat forehead. With this exception, I believe it comes closest to the subgenus *Mirotermes*, s. str. The mandibles are adapted for snapping and have the same form as in *Mirotermes*, s. str.

***Mirotermes* (*Crepititermes*) *verruculosus*, sp. nov.**

(Fig. 84)

Imago.—Head brown, widely oval, covered with short hair and bristles; thick in proportion to the length. Fontanelle a little darker than the rest of the head, inconspicuous.

Left mandible with 2 large teeth, one sharply pointed, the other rounded; right mandible with only 1 pointed tooth.

The 3d segment of the antennae very short, much shorter than the 4th, the 4th shorter than the 2d.

Eyes of medium size, not very prominent, fairly close to the lower margin

Ocelli of medium size, not prominent, about their own diameter removed from the eyes.

Postclypeus brown, median line faint.

Pronotum proportionately very long, about $\frac{3}{4}$ as long as wide; anterior margin straight; posterior margin rounded, forming a continuous curve with the sides.

Posterior margins of the meso- and metanota with small deep notches, sides strongly converging, angles sharp. Wings smoky; a light line between the media and cubitus in the basal half.

Front legs with 3 apical spines on the tibiae, one of which is rather difficult to see; 2 apical spines on the tibiae of all the other legs.

Abdominal tergites brown. Abdomen of queen covered with small warty spots.

Measurements.—

Length with wings	6.75– 7.00 mm.
Length without wings	4.30– 4.40 mm.
Length of head	.72– .83 mm.
Width of head	.61– .67 mm.
Diameter of eye	.22 mm
Length of pronotum	.43– .44 mm.
Width of pronotum	.51– .57 mm.
Length of hind tibia	.70– .73 mm.
Length of anterior wing	5.25– 5.51 mm.
Width of anterior wing	1.32– 1.35 mm.
Length of queen	21.00 mm.
Width of abdomen of queen	4.00 mm.

Soldier.—Head pale yellow, covered with short hairs; long, subrectangular, sides nearly parallel, converging sharply in front of the base of the antennae.

Antennae paler than the head, with 13 segments, reaching a little beyond the mandibles.

Labrum with 2 points, about $\frac{1}{4}$ the length of the mandibles.

Mandibles brown, slender, extreme end sharply curved, base broad with a tooth on the inner edge which is more conspicuous on the left mandible than on the right mandible.

Pronotum paler than the head, saddle-shaped, with a few bristles on the margins.

Abdomen the color of the contents of the intestines. Tergites and sternites covered with very short hairs.

Measurements.—

Total length	3.50–3.80 mm.
Length of head with mandibles	1.72–2.07 mm.
Width of head	.62– .73 mm.
Length of antennae	1.20–1.30 mm.
Width of pronotum	.40 mm.
Length of hind tibia	.52– .60 mm.
Length of left mandible	.95–1.03 mm.

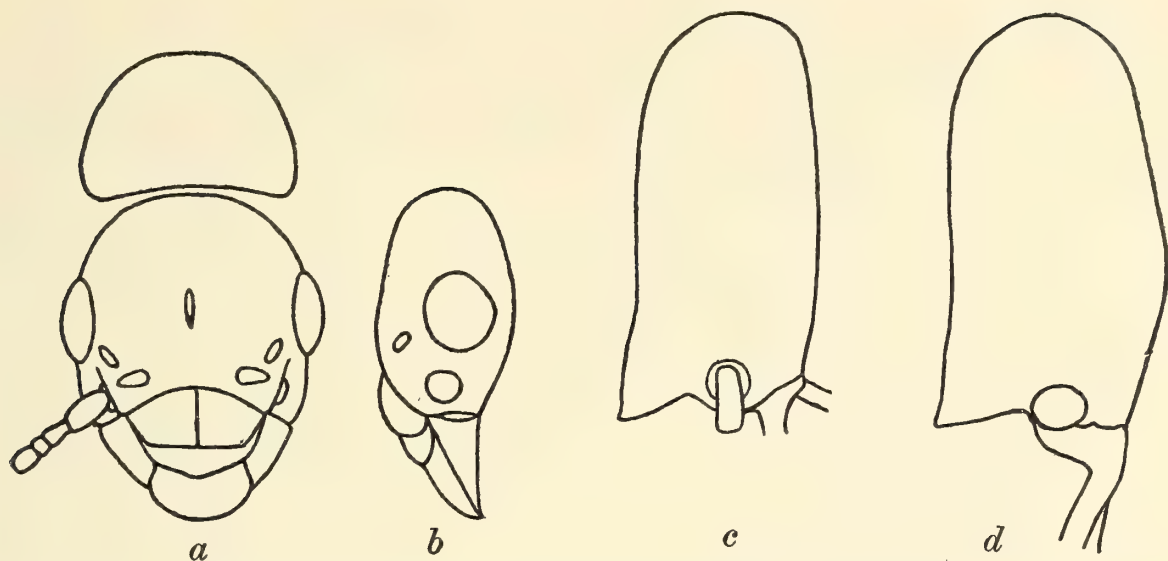


Fig. 85. *Mirotermes (Mirotermes) nigrinus* (Silvestri). *a*, imago, dorsal view of head and pronotum; *b*, imago, lateral view of head; *c*, soldier, lateral view of head.

Mirotermes (Mirotermes) hispaniolae Banks. *d*, soldier, lateral view of head.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Queen.

Morphotype.—Soldier.

The description is based upon two queens, many winged imagos and numerous soldiers collected by the author from six different colonies at Kartabo. The species is named after the peculiar warty appearance of the body of the queen, which is covered with minute slightly pigmented spots.

Subgenus *Mirotermes*, s. str. Holmgren

This subgenus includes thirty species with the new species described in this report. It has the widest distribution of any of the subgenera of *Mirotermes*, s. lat. and is found in all the warmer parts of the world. Eight species are reported from Australia and New Guinea, eight species from Africa and Madagascar, six species from the Oriental region and eight species from the Neotropical region.

Four species were found in British Guiana belonging to this subgenus of which two seem to be new.

Mirotermes (Mirotermes) nigrinus (Silvestri).

Capritermes saltans, subsp. *nigrinus* Silvestri (1901), p. 5 (imago).

Mirotermes saltans, subsp. *nigrinus* Silvestri (1903), p. 68 (imago), *text-fig. 16* (wings), p. 128 (biology).

Termes (Eutermes) saltans, subsp. *nigrinus* Desneux (1904c), p. 45 (synonymy).

Mirotermes (Mirotermes) nigrinus Holmgren (1912), p. 106, *text-fig. 75*, (mandibles of imago).

(Fig. 85 *a*, *b*, *c*)

Imago.—Head dark brown, oval. Fontanelle slit-shaped, rather small.

Antennae with 15 segments, the 2d longer than the 3d, the 2d equal to the 4th.

Eyes of medium size, not prominent, not very close to the lower margin. Ocelli about their width or a little more removed from the eyes; small.

Postclypeus a little lighter than the head, median line present but faint.

Pronotum a little lighter than the head, sides rounded, forming a nearly even curve with the posterior margin.

Posterior margins of the meso- and metanota deeply emarginate, nearly always forming an angle a little more than a right angle.

Wings dark smoky, veins distinct.

Abdominal tergites nearly as dark as the pronotum.

Measurements.—

Length with wings	8.50– 9.00 mm.
Length without wings	5.00– 5.50 mm.
Length of head	1.07– 1.10 mm.
Width of head . . . . .	.83– .90 mm.
Length of antennae	1.66 mm.
Diameter of eye . . . . .	.25 mm.
Length of pronotum . . . . .	.50 mm.
Width of pronotum . . . . .	.71– .80 mm.
Length of hind tibia	1.13– 1.17 mm.
Length of anterior wing	6.56– 7.26 mm.
Width of anterior wing	1.86– 2.16 mm.
Length of queen	21.00 mm.
Width of abdomen of queen	4.00 mm.

Comparison with other species.—I can find no good difference to separate the imagos of *M. nigritus* and *M. hispaniolae* with the possible exception of the slight differences in measurement.

Soldier.—Head dark yellow, sides straight and parallel, front a little wider than behind, sparsely covered with long bristles.

Antennae with 14 segments, the 2d equal to the 3d, the 4th slightly shorter.

Labrum not as deeply notched as in *M. hispaniolae*.

Nose rather short, not reaching the tip of the labrum, but a little more sharply pointed than in *M. hispaniolae*.

Pronotum pale, anterior margin not emarginate. Legs pale.

Abdominal tergites covered with hairs which are $\frac{1}{3}$ – $\frac{1}{2}$ as long as the marginal bristles. Abdomen the color of the intestinal contents.

Measurements.—

Total length	5.50–6.20 mm.
Length of head to tip of nose	1.35–1.70 mm.
Width of head . . . . .	.77–1.00 mm.
Length of antennae	2.23 mm.
Width of pronotum . . . . .	.63 mm.
Length of hind tibia . . . . .	.83– .87 mm.
Length of left mandible	1.67 mm.

Comparison with other species.—Close to *M. hispaniolae*, but differs by being smaller, nose sharper, and pilosity of the abdomen different.

Remarks.—I am not absolutely sure that my determination of this species is correct. The dentation of the imago mandible seems to agree with Holmgren's (1912, p. 106) figure and the description given by Silvestri agrees fairly well as far as it goes.

Type locality.—Coxipo (Cuyaba), Brazil.

New locality.—Kartabo, British Guiana.

Range.—Paraguay, Brazil, British Guiana.

The description is based upon many winged imagos, kings, queens, and soldiers collected by the author from 10 different colonies at Kartabo.

Mirotermes (Mirotermes) hispaniolae Banks.

Mirotermes hispaniolae Banks (1918), p. 662 (imago).

Mirotermes hispaniolae Banks (1919), p. 481 (soldier), pl. 1, figs. 2, 3 (soldier).

(Fig. 85d)

Imago.—Head dark brown, oval. Fontanelle slit-shaped and rather small. Antennae with the 2d segment a little longer than the 4th but not so thick, the 3d segment shorter than the 4th.

Eyes of medium size, not prominent and not very close to the lower margin of the head. Ocelli small, about their width or a little more removed from the eyes.

Postclypeus a little lighter than the head, median line present but faint.

Pronotum nearly as dark as the head, sides rounded, hind margin with a very slight indication of an emargination, anterior angles rather sharp.

Posterior margin of the mesonotum forming an angle which is much more than a right angle while that of the metanotum is about a right angle or a little more.

Abdominal tergites about the same color as the pronotum.

Measurements.—

Length of head.....	1.20– 1.27 mm.
Width of head.....	.96– 1.03 mm.
Diameter of eye.....	.27 mm.
Length of pronotum.....	.57 mm.
Width of pronotum.....	.90– .93 mm.
Length of hind tibia.....	1.00– 1.03 mm.
Length of queen.....	13.00 mm.
Width of abdomen of queen.....	3.00 mm.

Comparison with other species.—Very close to *M. nigrinus*, but slightly larger.

Soldier.—Head dark yellow, sparsely covered with long bristles; sides straight and parallel, hind margin somewhat rounded, head not wider in front than behind.

Antennae with 14 segments, the 3d longer than the 2d, the 2d equal to the 4th.

Labrum deeply notched at the tip, points sharp.

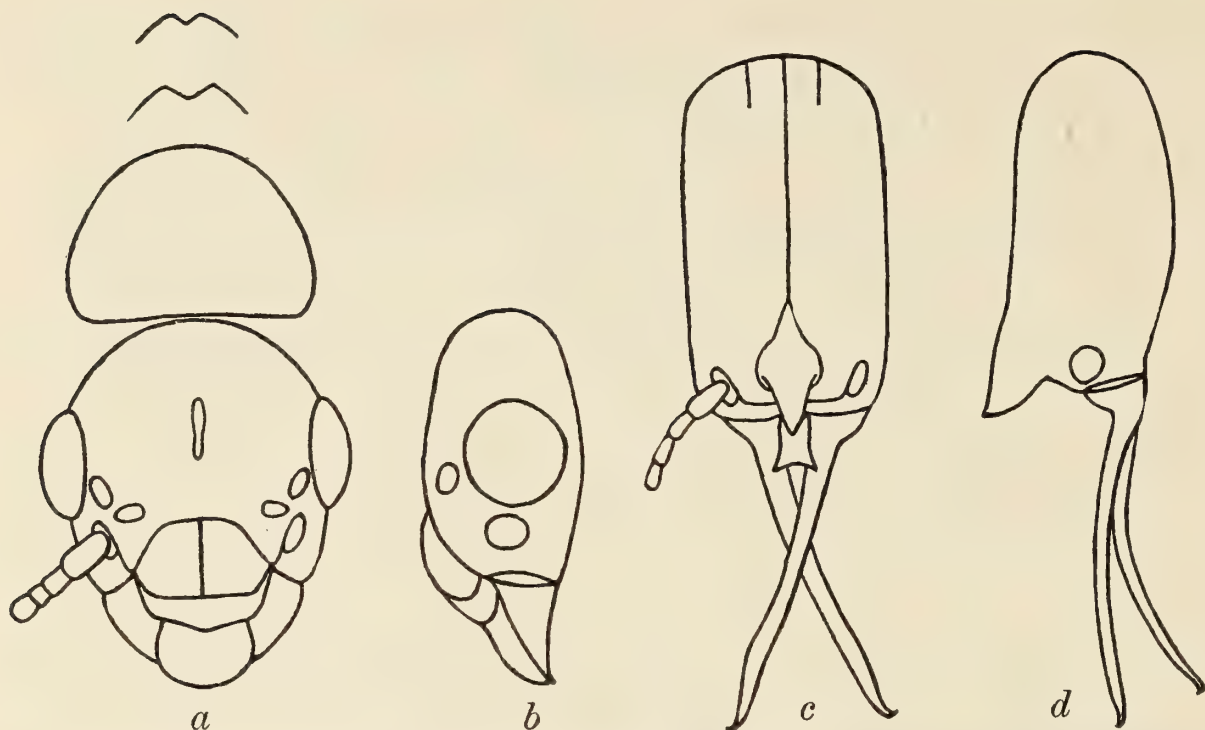


Fig. 86. *Mirotermes (Mirotermes) acutinasus*, sp. nov. *a*, imago, dorsal view of head, pronotum and margins of thoracic nota; *b*, imago, lateral view of head; *c*, soldier, dorsal view of head; *d*, soldier, lateral view of head.

Mandibles typical type, long and slender.

Nose rather short, not nearly reaching as far as the tip of the labrum, tip usually but not always a little upturned.

Pronotum pale, anterior margin not emarginate. Legs pale.

Abdominal tergites with rather long hair which is only a little shorter than the marginal bristles. Abdomen the color of the intestinal contents.

Measurements.—

Total length.....	6.50–7.00 mm.
Length of head.....	3.80 mm.
Length of head to tip of nose.....	1.54–1.70 mm.
Width of head.....	1.09–1.16 mm.
Length of antennae.....	2.40 mm.
Width of pronotum.....	.73 mm.
Length of hind tibia.....	.97–1.00 mm.
Length of left mandible.....	2.15 mm.

Comparison with other species.—*M. saltans* and *M. nigrinus* have a proportionately longer nose, shorter mandibles, and are smaller.

Remarks.—This species seems to coincide with the description given by Banks, and specimens determined by Banks agree, except that the soldier is smaller.

Type locality.—Panama.

New localities.—British Guiana: Kartabo, Georgetown; Trinidad, Port of Spain.

Range.—Haiti, Cuba, Panama, Trinidad, British Guiana.

The description is based upon a single king and queen and numerous soldiers collected by the author from three different colonies at Kartabo. Soldiers collected from a single colony at Georgetown and soldiers collected from a single colony in Trinidad agree with the Kartabo specimens.

***Mirotermes (Mirotermes) acutinasus*, sp. nov.**

(Fig. 86)

Imago.—Head dark brown, oval. Fontanelle slit-shaped, conspicuous.

Antennae with the 3d segment small, the 2d equal to the 4th.

Eyes proportionately large and fairly close to the lower margin. Ocelli decidedly less than their width from the eyes.

Postclypeus lighter than the head, median line faint.

Pronotum lighter than the head, sides and posterior margins rounded.

Posterior margins of the meso- and metanota emarginate.

Abdominal tergites the same color as the pronotum.

Measurements.—

Length of head	1.17 mm.
Width of head	1.03 mm.
Diameter of eye . . . . .	.36 mm.
Length of pronotum . . . . .	.60 mm.
Width of pronotum . . . . .	.90 mm.
Length of hind tibia	1.13 mm.

Comparison with other species.—Quite close to *M. saltans* Silvestri (1903). However, the dentation of the mandibles as figured by Holmgren (1912, p. 106) is quite different, and the eye of *M. saltans* is smaller, measuring only .28 mm. in diameter. Very close to *M. nigrinus*, but the ocelli are conspicuously less than their width from the eyes and *M. acutinasus* is also a little larger than *M. nigrinus*.

Soldier.—Head dark yellow, sparsely covered with bristles; sides straight and parallel; wider in front than behind.

Antennae with 14 segments, the 2d longer than the 3d, the 3d equal to the 4th.

Labrum somewhat notched at the tip. Mandibles typical.

Nose sharp and long, extending well beyond the base of the antennae.

Pronotum pale, not emarginate on the anterior border. Legs pale.

Abdomen the color of the intestinal contents. Tergites covered with hair about $\frac{1}{2}$ the length of the bristles.

Measurements.—

Total length	6.00–6.50 mm.
Length of head to tip of nose	1.90 mm.
Width of head . . . . .	.97 mm.
Length of antennae	2.10 mm.
Width of pronotum . . . . .	.63 mm.

Measurements.—

Length of hind tibia . . . . .	.93 mm.
Length of left mandible	1.96 mm.

Comparison with other species.—Differs from *M. nigrinus* and *M. hispaniolae* in having a longer, sharper nose which extends much beyond the base of the antennae.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—King.

Morphotype.—Soldier.

The description is based upon one king, two queens, and many soldiers collected from 2 different colonies by the author at Kartabo.

Mirotermes (Mirotermes) inquilinus, sp. nov.

(Fig. 87)

Imago.—Head dark brown, widely egg-shaped, covered with very small hairs, no long bristles present. Fontanelle slit-shaped, about as long or a little longer than the ocelli. 2 inconspicuous muscle insertions in front of the ocelli.

Antennae with 15 segments, the 3d very short, sometimes just separating from the 4th.

Eyes of medium size, prominent, about $\frac{1}{4}$ their diameter from the lower margin. Ocelli small, about $\frac{1}{2}$ their length removed from the eyes.

Postclypeus lighter than the head, long and arched, about as long as $\frac{1}{2}$ its width, median line present.

Pronotum dark brown, sometimes slightly wider than the head, sides straight and depressed, posterior margin rounded.

Posterior margins of the meso- and metanota emarginate.

Wings dark smoky, veins distinct, media usually unbranched.

Abdominal tergites dark brown.

Measurements.—

Length with wings	13.00–14.00 mm.
Length without wings	6.20– 8.50 mm.
Length of head	1.50– 1.70 mm.
Width of head	1.46– 1.60 mm.
Length of antennae	1.70– 2.03 mm.
Diameter of eye . . . . .	.38 mm.
Length of pronotum . . . . .	.90 mm.
Width of pronotum	1.54– 1.55 mm.
Length of hind tibia	1.37 mm.
Length of anterior wing	10.16–10.63 mm.
Width of anterior wing	2.58– 2.70 mm.

Comparison with other species.—*M. fur* Silvestri has 17 segments in the antennae. *M. microcerus* Silvestri is a little smaller.

Soldier.—Head yellow, front and nose slightly darker; covered with a few

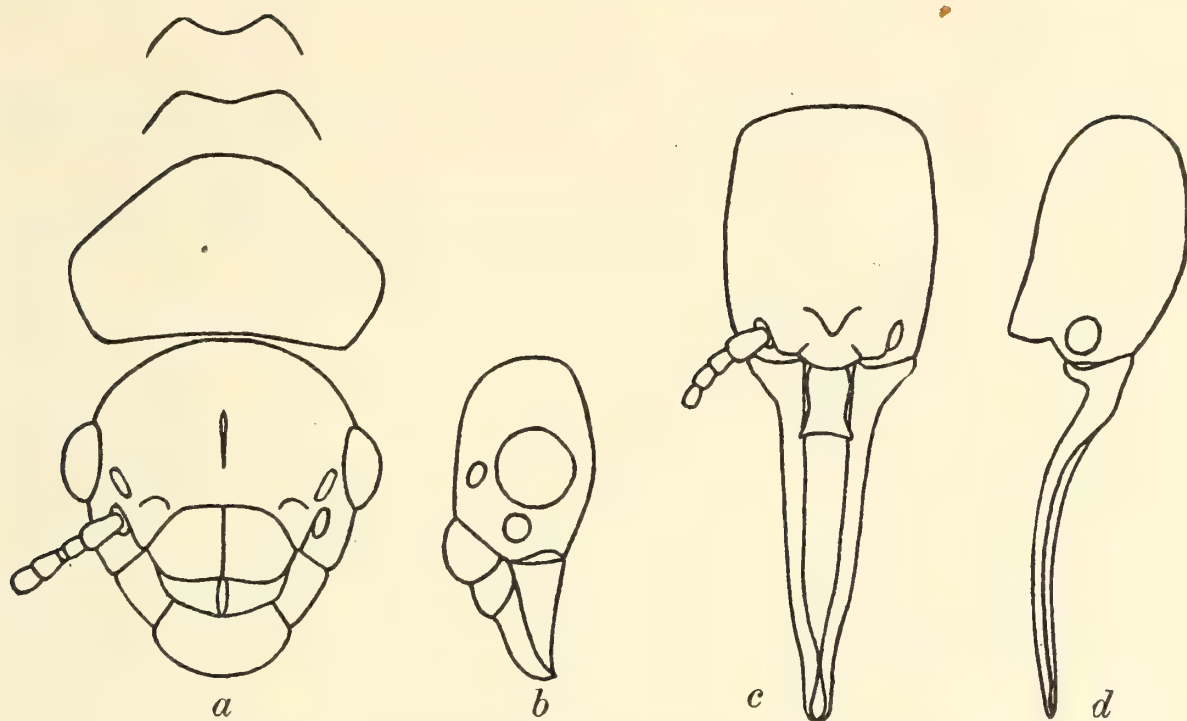


Fig. 87. *Mirotermes (Mirotermes) inquilinus*, sp. nov. a, imago, dorsal view of head, pronotum and margins of thoracic nota; b, imago; lateral view of head; c, soldier, dorsal view of head; d, soldier, lateral view of head.

very small bristles and microscopical hairs; subrectangular, sides and posterior margin slightly curved.

Antennae yellow, with 14 segments.

Mandibles black, much longer than the head.

Nose hairy, profile with pointed end.

Thorax pale. Pronotum with very short hairs and bristles, anterior margin very slightly emarginate. Legs pale.

Abdomen pale, tergites with very short hairs and bristles.

Measurements.—

Total length	7.00–8.00 mm.
Length of head	3.80–4.00 mm.
Length of head without mandibles	2.07–2.10 mm.
Width of head	1.30–1.45 mm.
Length of antennae	2.67 mm.
Width of pronotum . . . . .	.97 mm.
Length of hind tibia . . . . .	.95–.97 mm.
Length of left mandible	2.41–2.54 mm.

Comparison with other species.—*M. fur* Silvestri is much larger. *M. microcerus* Silvestri has shorter mandibles.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Winged imago.

Morphotype.—Soldier.

The description is based upon numerous winged imagos, several kings and queens, and many soldiers collected by the author from six different colonies at Kartabo.

This species has a peculiar habit of always living in the nest of *Nasutitermes* (*Constrictitermes*) *cavifrons* (Holmgren). The name of the species was suggested by this habit, the details of which will follow in a later paper.

Subgenus **Cavitermes**, subgen. nov.

The soldier of this remarkable species differs so much in the shape of the head from species belonging to the other subgenera of *Mirotermes* that it seemed to me best to include it in a new subgenus. *Cavitermes* seems to be nearest to *Mirotermes*, s. str. than to any other subgenus but it differs from the typical *Mirotermes*, s. str. in the ridges along the forehead of the soldier and the hollowed front which suggested the name. The mandibles of the soldier are similar in shape and adaptation to those of *Mirotermes*, s. str.

Mirotermes (Cavitermes) tuberosus, sp. nov.

(Fig. 88)

Imago.—Head dark brown, oval, covered with short hairs and a few longer bristles. Fontanelle small and inconspicuous.

Antennae with 15 segments (entire on one of the queens), the 3d very small, the 4th a little shorter than the 2d.

Eyes rather small and not prominent, not very close to the lower margin of the head. Ocelli rather small, long, less than their width from the eyes.

Postclypeus nearly as dark as the head, about as long as $\frac{1}{2}$ its width; median line present but faint.

Pronotum dark brown, proportionately short and wide, sides rounded, converging toward the rear, anterior angles rather sharp, posterior margin very slightly or not emarginate.

Posterior margins of the meso- and metanota widely concave.

Abdominal tergites as dark as the pronotum.

Measurements.—

Length of head	1.23 mm.
Width of head	1.03 mm.
Length of antennae	1.66 mm.
Diameter of eye . . . . .	.28 mm.
Length of pronotum . . . . .	.50 mm.
Width of pronotum . . . . .	.98 mm.
Length of hind tibia	1.23 mm.
Length of queen	8.00 mm.
Width of abdomen of queen	2.00 mm.

Soldier.—Head dark yellow, roughly rectangular from above, widening abruptly, however, at the posterior end, posterior margin rounded; a distinct

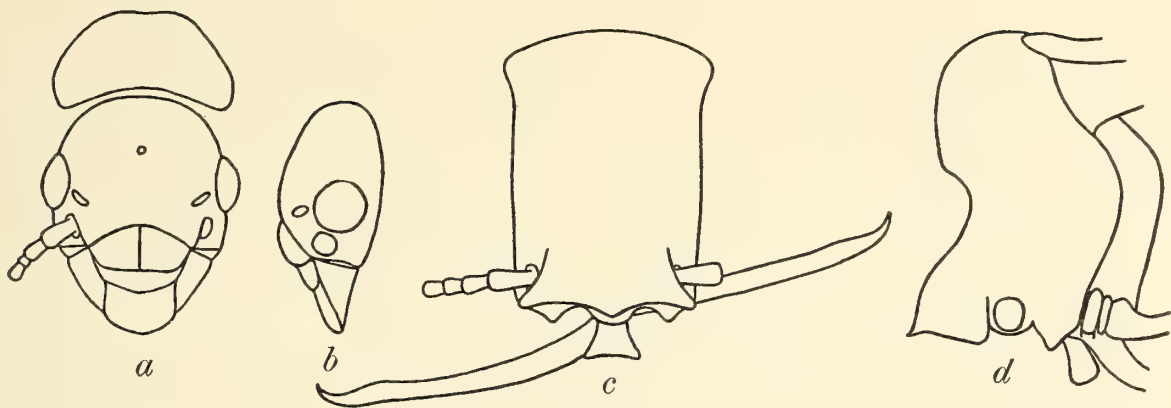


Fig. 88. *Mirotermes (Cavitermes) tuberosus*, sp. nov. *a*, imago, dorsal view of head and pronotum; *b*, imago, lateral view of head; *c*, soldier, dorsal view of head; *d*, soldier, lateral view of head.

tubercle on each side of the head on the vertex; profile with a remarkably deep depression in the middle; head prolonged in front into a 3-pointed sharp projection, the tip sharp and upturned in profile; front hollowed out, a distinct projection on each side of the clypeus.

Antennae same color as the head, with 14 segments, the 2d longer than the 3d, the 3d equal to the 4th, the 5th more than two times the length of the 4th.

Labrum 2-pointed, anterior margin slightly concave, sides converging toward the rear.

Mandibles similar to those of *Mirotermes*, s. str., modified for snapping; a short blunt tooth near the base followed by an upturned comparatively long tooth.

Pronotum pale, anterior margin evenly rounded. Legs pale.

Abdomen the color of the intestinal contents, tergites covered with hair.

Measurements.—

Total length.....	5.00–6.00 mm.
Length of head with mandibles.....	3.43 mm.
Length of head to tip of nose.....	1.67–1.77 mm.
Width of head.....	1.10–1.17 mm.
Length of antennae.....	2.20 mm.
Width of pronotum.....	.63–.67 mm.
Length of hind tibia.....	.87 mm.
Length of left mandible.....	1.93 mm.

Type locality.—Barakara (Bartica District), British Guiana.

Other localities.—Cow Island (Bartica District), British Guiana; St. Joseph, Trinidad.

Range.—British Guiana, Trinidad.

Holotype.—Soldier.

Morphotype.—Queen.

The description is based upon one queen and many soldiers collected from a single colony at Barakara, one king and queen and numerous soldiers collected from a single colony at Cow Island, and 2 soldiers collected from a single colony

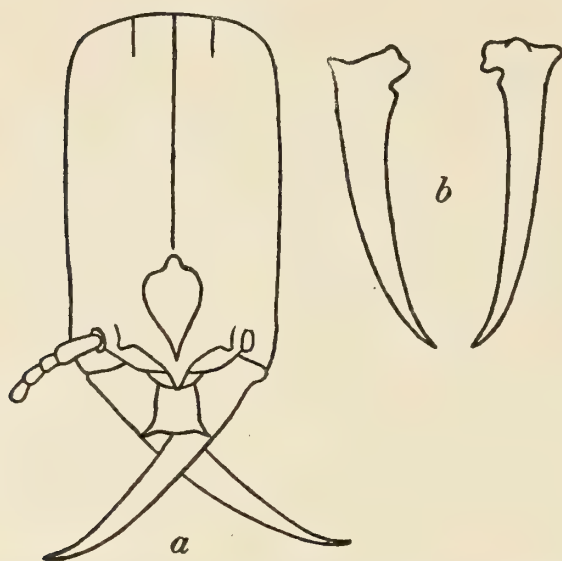


Fig. 89. *Mirotermes* (*Spinitermes*) *trispinosus* (Hagen). *a*, soldier, dorsal view of head; *b*, soldier, mandibles.

in Trinidad by the author. The species is named after the few tubercles on the top of the head and on either side of the clypeus.

Subgenus *Spinitermes* Wasmann

This subgenus includes four species all of which are found only in South America. The single species found in British Guiana I have referred to one of these four species. They are difficult to distinguish apart, however, and my determination may be wrong.

Mirotermes (*Spinitermes*) *trispinosus* (Bates).

- Termes trispinosus* Bates in Hagen (1858), p. 211.
Termes trispinosus Hagen (1858), p. 210 (soldier), pl. 1, fig. 11 (soldier).
Termes trispinosus Hagen (1858a), p. 29 (imago).
Termes (*Spinitermes*) *trispinosus* Wasmann (1897), p. 152.
 (?) *Spinitermes trispinosus* Silvestri (1901), p. 6.
 (?) *Spinitermes trispinosus* Silvestri (1903), p. 71 (soldier, worker), p. 129 (biology), pl. 3, fig. 230 (soldier).
Termes (*Eutermes*) *trispinosus* Desneux (1904c), p. 46 (synonymy).
Mirotermes (*Spinitermes*) *trispinosus* Holmgren (1912), p. 109.

(Fig. 89)

Soldier.—Head yellow, front darker; clothed with a few short bristles; subrectangular, sides straight and parallel, posterior margin rounded.

Antennae with 14 segments, slightly darker than the head.

Labrum slightly darker than the head, wide, 2-pointed.

Mandibles black, slightly curved, smooth except for the teeth at the base.

Nose in some cases turned up at the tip; hairy; with 3 points, the 2 side projections smaller than the middle one.

Thorax pale. Pronotum with the anterior margin rounded. Legs pale.

Abdominal tergites pale, covered with short hair and a few bristles.

Measurements.—

Total length	5.00–7.00 mm.
Length of head	2.75–3.00 mm.

Measurements.—

Length of head without mandibles	1.86–2.12 mm.
Width of head	1.03–1.26 mm.
Length of antennae	1.50–1.90 mm.
Width of pronotum . . . . .	.68 mm.
Length of hind tibia . . . . .	.97 mm.
Length of left mandible	1.51 mm.

Comparison with other species.—This species does not seem to correspond to the species described under *Spinitermes trispinosus* by Silvestri (1903). His species has a wider head and the two side projections of the frontal process are proportionately larger. *M. gracilis* Holmgren has a shorter frontal process and the labrum tip is concave without a convex center portion. I am unable to find any good character to separate *M. nigrostomus* Holmgren and *M. trispinosus* in the descriptions of these species and I believe they are the same. Hagen's type soldier in the Museum of Comparative Zoology at Cambridge is very close to the specimens from British Guiana, the head being slightly broader and the mandibles slightly stouter. I believe, however, that they are the same species. A soldier determined by Silvestri of *M. brevicornutus* (Desneux) in the U. S. National Museum, has a broader head than *M. trispinosus* from Kartabo.

Type locality.—Santarem, Brazil.

New locality.—Kartabo, British Guiana.

Range.—Brazil, British Guiana.

The description is based upon many specimens of soldiers collected from five different colonies by the author at Kartabo.

Genus *Capritermes* Wasmann

In the widest sense, this genus is composed of three groups of species which are close enough, however, to keep them in subgenera. They are distributed over all parts of the tropics. *Capritermes*, s. str. includes twenty-three species distributed over Africa, Madagascar, Oriental region, German New Guinea, and Australia. *Pericapritermes* includes four species, all from the African continent. *Neocapritermes* is discussed below.

Subgenus *Neocapritermes* Holmgren

This subgenus includes eight species with the new species described in this report. All of these are found on the South American mainland with the exception of *Capritermes alienus* von Rosen from Africa. Three species were found in British Guiana, one of which was recently described by Silvestri and the others proved to be new.

Capritermes (Neocapritermes) bodkini Silvestri.

Capritermes Bodkini Silvestri (1923), p. 312 (imago, nymph, soldier, worker), pl. XIII (soldier, nymph).
Capritermes Bodkini var. *modestior* Silvestri (1923), p. 315 (imago, soldier, worker), pl. XIV (imago, soldier, worker).

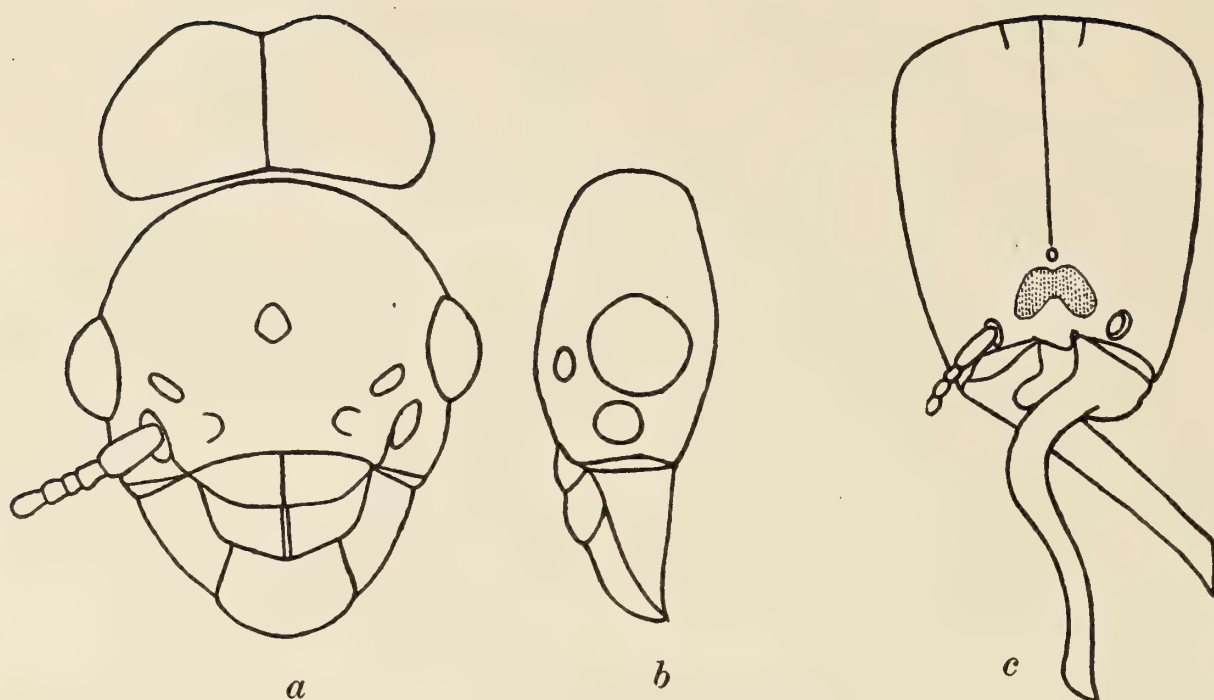


Fig. 90. *Capritermes* (*Neocapritermes*) *bodkini* Silvestri. *a*, imago, dorsal view of head and pronotum; *b*, imago, lateral view of head; *c*, soldier, dorsal view of head.

(Fig. 90)

Imago.—Head rather light brown, widely oval, clothed with a few long bristles. Fontanelle a little darker than the head, large and round. Indistinct muscle insertions in front of the ocelli.

3d segment of the antennae shorter than the 4th, 4th shorter than the 2d, or 3d longer than the 2d, the 2d equal to the 4th.

Eyes of medium size, prominent, about $\frac{1}{4}$ their diameter from the lower margin.

Ocelli of medium size, about their own length from the eyes

Postclypeus about the same color as the head, median line distinct.

Pronotum about the same color as the head, with short hairs and bristles; rather wide, posterior margin deeply emarginate, angles and sides rounded.

Posterior margins of the meso- and metanota widely emarginate or with a rather small notch. Considerable variation is noticeable in this character.

Abdominal tergites rather light brown.

Measurements.—

Length of head.....	2.14–2.36 mm.
Width of head.....	1.93–2.10 mm.
Diameter of eye.....	.52–.53 mm.
Length of pronotum.....	.86–.87 mm.
Width of pronotum.....	1.60–1.75 mm.
Length of hind tibia.....	2.62–2.67 mm.

Comparison with other species.—I am of the opinion that Silvestri's varieties are only variations in size due to the age of the colony from which they were taken, and cannot be considered true varieties. I have what seem to be both

varieties from Kartabo from different colonies, one with a relatively undeveloped king and queen and rather small soldiers, the other colony large with large soldiers, no king and queen being found.

Soldier.—Head yellow, sparsely covered with short bristles. Head widest behind, narrowing toward the front, a distinct line running from the back of the head to the gland opening.

Antennae a little brownish, with 15–16 segments, the 2d, 3d, and 4th segments equal.

Labrum thrust aside to fit the conformation of the mandibles, rounded at the tip. Mandibles asymmetrical, black, left mandible curved more than in *C. angusticeps* and less curved than in *C. planiceps*.

Thorax yellow. Pronotum about $\frac{1}{2}$ the width of the head, anterior margin emarginate. Legs yellow,

Abdomen the color of the intestinal contents. Tergites with a few marginal bristles.

Measurements.—

Total length.....	9.00–12.10 mm.
Length of head with mandibles.....	6.82– 7.26 mm.
Width of head.....	3.70– 3.73 mm.
Length of antennae.....	4.46 mm.
Width of pronotum.....	1.40 mm.
Length of hind tibia.....	2.71 mm.
Length of left mandible.....	3.58 mm.

Type locality.—British Guiana: Tumatumari (Potaro River).

Other localities.—Kartabo, British Guiana.

Range.—Known only from British Guiana.

The description is based upon a single king and queen, many dealated couples (some of which were found with a few diminutive workers and soldiers or eggs), and many soldiers. The soldiers were compared with specimens collected by G. E. Bodkin from Tumatumari and were found to agree.

Capritermes (Neocapritermes) angusticeps, sp. nov.

(Fig. 91)

Imago.—Head brown, widely oval, sparsely clothed with a few long bristles. Fontanelle lighter than the head, much smaller than the ocelli.

Antennae with 17 segments, 3d slightly smaller than the 4th, 4th much smaller than the 2d.

Eye rather large, .10 mm. from the lower margin. Ocelli of medium size, less than their width from the eyes.

Postclypeus lighter than the head, median line rather faint.

Pronotum a little lighter than the head; clothed with short hairs and longer bristles; rather wide; posterior margin somewhat emarginate; angles and sides rounded.

Posterior margin of mesonotum with a right-angled notch. Notch of the posterior margin of the metanotum more than a right angle.

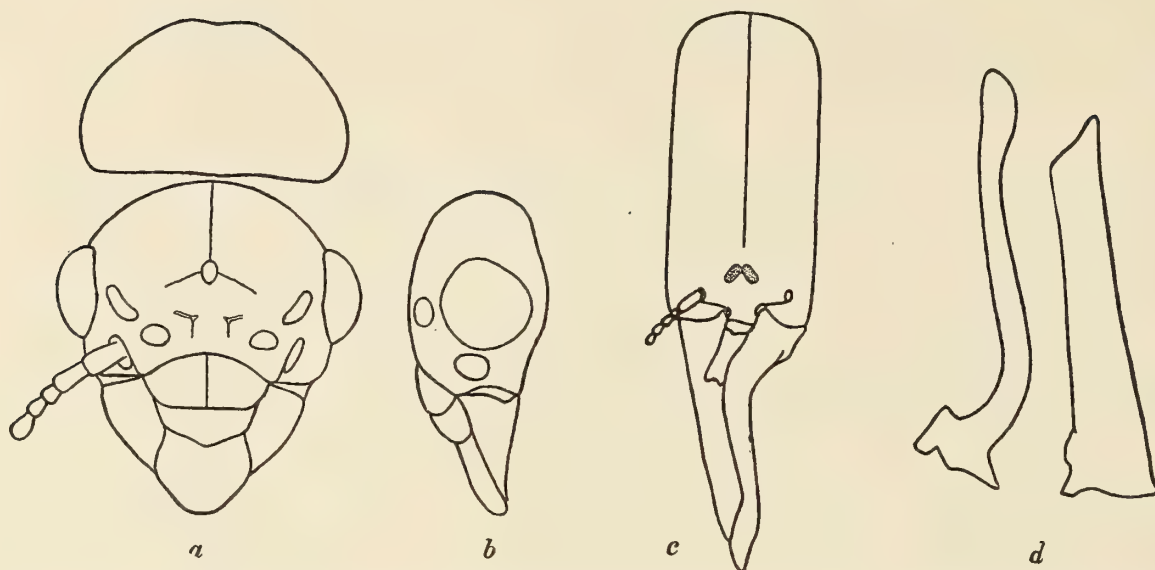


Fig. 91. *Capritermes* (*Neocapritermes*) *angusticeps*, sp. nov. a, imago, dorsal view of head and pronotum; b, imago, lateral view of head; c, soldier, dorsal view of head; d, soldier, mandibles.

Wings dark smoky; a light streak between the media and cubitus. Abdominal tergites the same color as the pronotum.

Measurements.—

Length with wings	16.00–17.40 mm.
Length without wings	10.00–11.00 mm.
Length of head	1.83– 1.93 mm.
Width of head	1.60– 1.67 mm.
Length of antennae	2.83– 3.07 mm.
Diameter of eye . . . . .	.50– .57 mm.
Length of pronotum . . . . .	.93– .97 mm.
Width of pronotum	1.43– 1.53 mm.
Length of hind tibia	1.73– 1.75 mm.
Length of anterior wing	12.55–13.75 mm.
Width of anterior wing	3.24– 3.40 mm.

Soldier.—Head yellow, front slightly darker than the rest, a dark line in the middle extending from the back of the head to the gland opening; sparsely clothed with bristles. Head long and narrow, sides nearly straight, posterior margin slightly rounded.

Antennae slightly darker than the head, with 16 segments.

Labrum thrust aside to fit the mandibles, the tip somewhat concave with 2 conspicuous lobes and a suggestion of a third lobe in the middle.

Mandibles black, asymmetrical, large and powerful.

Pronotum pale, sparsely clothed with bristles; about $\frac{3}{4}$ the width of the head, anterior region forming a large lip and weakly emarginate.

Abdomen pale, sparsely clothed with bristles.

Measurements.—

Total length	8.00–12.00 mm.
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Measurements.—

Length of head with mandibles	5.90– 7.00 mm.
Length of head without mandibles	3.86– 4.55 mm.
Width of head	1.46– 1.92 mm.
Length of antennae	3.00– 3.06 mm.
Width of pronotum	1.10– 1.14 mm.
Length of hind tibia	1.39– 1.49 mm.
Length of left mandible	3.00– 3.32 mm.

Comparison with other species.—This is not the species described by Sørensen under *Termes oreensis*, as the labrum is 3-lobed in that species. *Termes oreensis* has been referred to *C. opacus*. *C. angusticeps* does not agree with Hagen's (1858) description of *Termes cingulatus*, now referred to *C. opacus*, in that the pronotum is not conspicuously emarginate in front and the mandibles are not 3.50 mm. long. *Termes lacus sancti* Sørensen, also referred to *C. opacus*, seems to be the same as Hagen's *Termes cingulatus* in both these respects. Both the forms described by Silvestri (1903) as *C. opacus* and *C. opacus parvus* have a 3-lobed labrum. Also *C. villosus* Holmgren has a 3-lobed labrum. *C. talpa* Holmgren seems fairly close, but the head is larger.

Type locality.—Kartabo, British Guiana.

Other localities.—Dunoon, British Guiana.

Range.—Known only from British Guiana.

Holotype.—Soldier.

The description is based upon many soldiers and imagos taken from eight different colonies at Kartabo by the author and several soldiers collected from a single colony at Dunoon by F. M. Gaige.

Capritermes (Neocapritermes) planiceps, sp. nov.

(Fig. 92)

Soldier.—Head pale yellow, the front a little darker; covered with bristles of varying length; head very flat, sides fairly straight, converging slightly toward the front, posterior margin 3-lobed, the middle lobe smaller than those on the sides, which extend back as far as the middle of the prothorax, the middle lobe usually covered by the prothorax.

Antennae yellow, with 14 segments.

Labrum thrust aside to fit the mandibles.

Mandibles extremely asymmetrical, the left strongly curved.

Thorax pale yellow. Pronotum small, about $\frac{1}{3}$ the width of the head, anterior margin emarginate, distinct anterior lip present.

Abdomen pale yellow. Tergites with long and short bristles.

Measurements.—

Total length	4.75–4.90 mm.
Length of head (with mandibles)	2.35–2.53 mm.
Width of head	1.35–1.37 mm.
Length of antennae	1.90–1.92 mm.

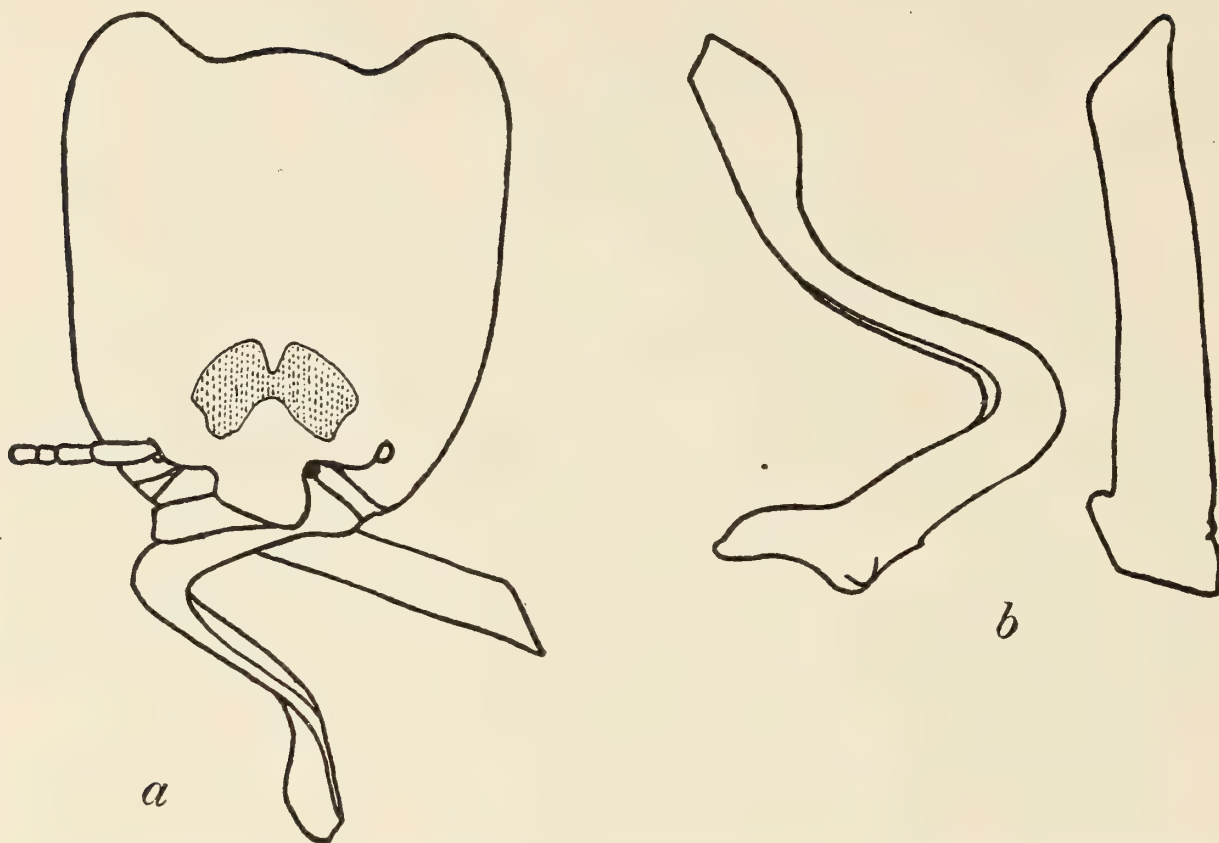


Fig. 92. *Capritermes* (*Neocapritermes*) *planiceps*, sp. nov. *a*, soldier, dorsal view of head; *b*, soldier, mandibles.

Measurements.—

Length of pronotum.....	.30- .36 mm.
Width of pronotum.....	.50- .57 mm.
Length of hind tibia.....	.75- .83 mm.
Length of left mandible.....	1.18-1.23 mm.

Comparison with other species.—Unlike any other species of the genus in the shape of the head, particularly the flatness and the lobed posterior margin.

Worker.—Mandibles with the same dentation as that found in *C. bodkini*.

Type locality.—Kartabo, British Guiana.

Range.—Known only from the type locality.

Holotype.—Soldier.

The description is based upon numerous soldiers collected from three different colonies by the author at Kartabo.

These soldiers are so different from the known representatives of the genus that they may belong to a new subgenus. However, I can find no fundamental character in the soldier to differentiate it from the typical members of the subgenus *Neocapritermes*, so I believe it best to place it in this subgenus, at least for the present. When the imago is found, it may be that characters may be found that will separate this species from the other groups.

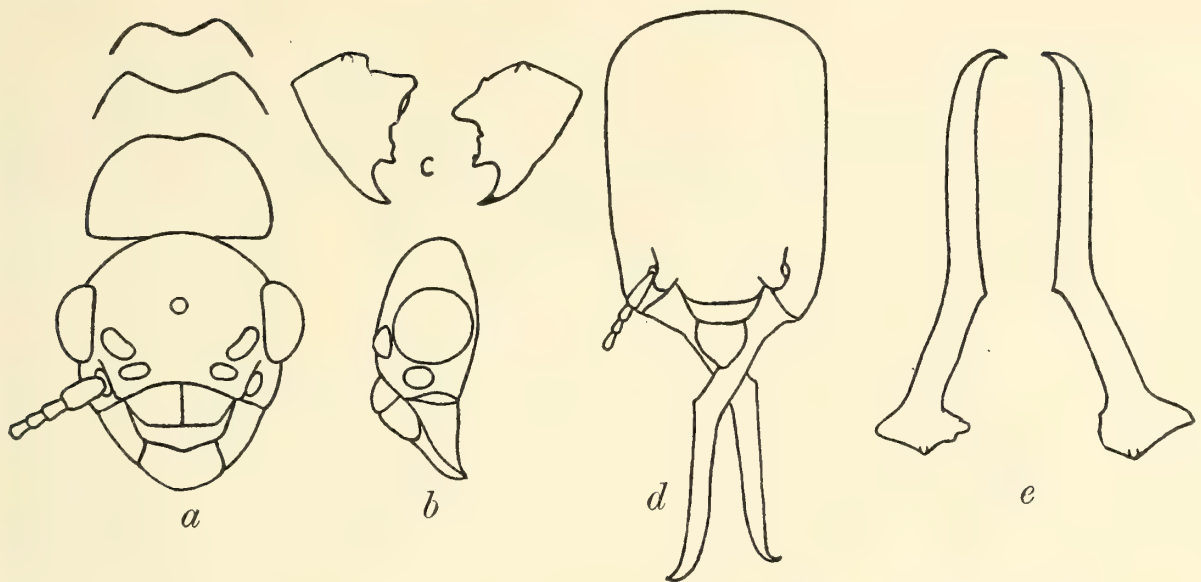


Fig. 93. *Orthognathotermes macrocephalus* (Holmgren). *a*, imago, dorsal view of head, pronotum and margins of thoracic nota; *b*, imago, lateral view of head; *c*, imago, mandibles; *d*, soldier, dorsal view of head; *e*, soldier, mandibles.

Genus *Orthognathotermes* Holmgren

This genus includes only three species, all from the Neotropical region. One other species, *Mirotermes globicephalus* Silvestri (1903), has been doubtfully placed in this genus by Holmgren (1912), but the differences are sufficient to include *M. globicephalus* in a new genus.

Only one species of *Orthognathotermes* was found in British Guiana and that seems to answer the description of *Orthognathotermes macrocephalus* given by Holmgren (1906).

Orthognathotermes macrocephalus (Holmgren).

Mirotermes macrocephalus Holmgren (1906), p. 562 (soldier, worker), text-fig. T (soldier), text-fig. U (worker).
Orthognathotermes macrocephalus Holmgren (1912), p. 119, 118, text-fig. 84 (mandible of nymph), text-fig. 85 (soldier).

(Fig. 93)

Imago.—Head rather dark brown, lighter around the base of the antennae; widely oval; hairy with a few long bristles. Fontanelle round, white, much smaller than the ocelli. 2 large muscle insertions in front of the ocelli but not conspicuous.

Antennae with 17 segments, 2d segment a little longer than the 3d, the 3d equal to the 4th; 1st segment and end segments yellow, middle darker.

Ocelli very large, less than $\frac{1}{4}$ their length removed from the eyes. Eyes very large, very prominent and very close to the lower margin.

Mandibles with the tips sharply pointed, the right with a prominent pointed tooth and a large projection near the base. Labrum yellow.

Postclypeus yellow, contrasting strongly with the head, median line present.

Pronotum brown, lighter than the head, some light marks near the anterior margin and in the middle; hairy with a few long bristles; sides rounded, posterior margin slightly emarginate.

Posterior margins of the meso- and metanota widely concave, angles rather sharp.

Wings smoky; costal border, radius and veins near the scale dark; media and cubitus indistinct near the apex; radius runs parallel to the costal border; media parallel to the cubitus, single or with 2-3 branches; cubitus with 10-11 branches. Tibiae of front legs with 3 apical spines, hind tibiae with 2 apical spines.

Abdominal tergites light brown, hairy with a few long bristles. Sternites pale.

Measurements.—

Length with wings	12.00-14.00 mm.
Length without wings	7.00- 8.00 mm.
Length of head	1.60- 1.75 mm.
Width of head	1.40- 1.48 mm.
Length of antennae	3.00- 3.17 mm.
Diameter of eye . . . . .	.47 mm.
Length of pronotum . . . . .	.64- .67 mm.
Width of pronotum	1.07- 1.17 mm.
Length of anterior wing	9.86-10.00 mm.
Width of anterior wing	3.17- 3.20 mm.

Soldier.—Head yellow, front brownish; clothed with a few scattered short bristles; head subrectangular, widest behind, posterior margin somewhat rounded; 2 conspicuous raised lobes overhanging the base of the antennae.

Antennae brownish, with 15 segments, the 3d smaller than the 2d or 4th. Labrum weakly 3-lobed.

Mandibles brownish black, long and strong, similar to each other; tips curved, a small tooth about $\frac{2}{5}$ of the length from the base, the mandibles bent at this point; strongly convex from the side.

Thorax pale. Pronotum hairy, raised anterior region large, the front margin emarginate.

Legs pale, 3 apical spines on the front tibiae, 2 on all the other tibiae.

Abdomen pale; tergites hairy.

Measurements.—

Total length	8.00-9.00 mm.
Length of head to tip of labrum	3.00-3.32 mm.
Length of head with mandibles	5.03-5.07 mm.
Width of head	1.90-1.92 mm.
Length of antennae	2.27-2.57 mm.
Width of pronotum	1.07-1.25 mm.
Length of hind tibia	1.49-1.57 mm.
Length of left mandible	2.36-2.53 mm.

Comparison with other species.—*O. orthognathus* Silvestri has longer mandibles and larger head. The difference between the species is not great, however.

Type locality.—Mojos (Prov. Caupolican), Bolivia.
New locality.—Kartabo, British Guiana.
Range.—Bolivia, British Guiana.

The description is based upon numerous winged imagos and soldiers collected from four colonies at Kartabo by the author.

Genus *Microcerotermes* Silvestri

This genus now includes forty-two species from all the warm parts of the globe. Sixteen species are known from the Ethiopian region, Madagascar and the adjoining islands; ten species are known from the Oriental region; nine species are recorded from the Australian region, including German New Guinea and the Samoan Islands; three species are reported from the Palearctic region; and four species, including the new species described below, are recorded from the New World.

***Microcerotermes arboreus*, sp. nov.**

(Fig. 94)

Imago.—Head very dark blackish brown, covered with rather long hair; oval; muscle insertions not conspicuous. Fontanelle smaller than the ocelli, sometimes rather inconspicuous.

Antennae with 14 segments, the 3d very short, the 4th somewhat shorter than the 2d.

Eyes rather small, fairly prominent, about $\frac{1}{3}$ their diameter from the lower margin. Ocelli small, more than their diameter from the eyes.

Postclypeus somewhat lighter than the head with a faint median line; about as long as $\frac{1}{2}$ its width.

Pronotum the same color as the postclypeus, slightly lighter than the head; sides fairly straight, posterior margin slightly emarginate; posterior angles rounded.

Posterior margins of the meso- and metanota rather widely emarginate.

Upper part of the tibiae dark. Wings smoky.

Abdominal tergites blackish brown.

Measurements.—

Length with wings	8.03– 9.00 mm.
Length without wings	5.50– 6.50 mm.
Length of head	1.10– 1.20 mm.
Width of head	.90– .97 mm.
Length of antennae	1.38– 1.50 mm.
Diameter of eye	.27 mm.
Length of pronotum	.45– .47 mm.
Width of pronotum	.71– .73 mm.
Length of hind tibia	.96– 1.00 mm.
Length of anterior wing	6.50– 7.43 mm.
Width of anterior wing	1.89– 2.10 mm.
Length of queen	20.00 mm.

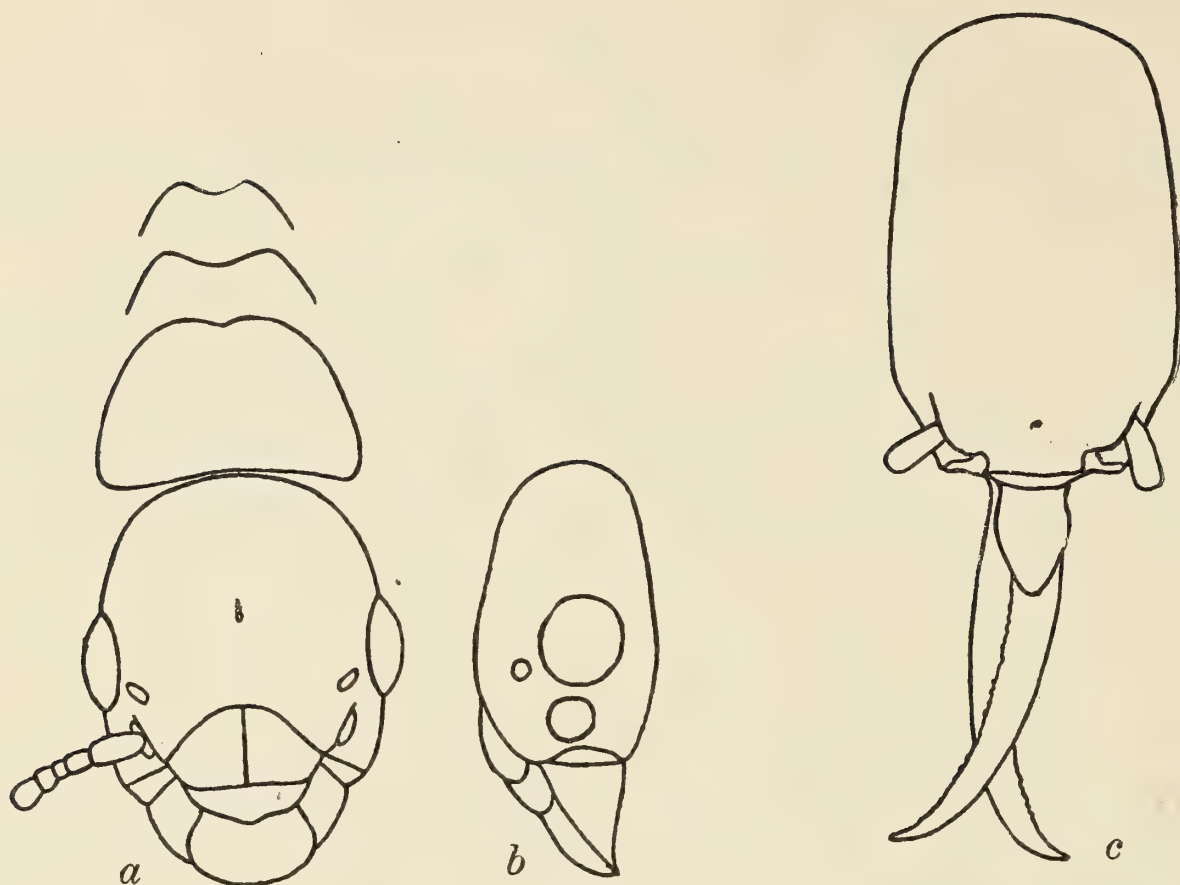


Fig. 94. *Microcerotermes arboreus*, sp. nov. *a*, imago, dorsal view of head, pronotum and margins of thoracic nota; *b*, imago, lateral view of head; *c*, soldier, dorsal view of head.

Comparison with other species.—Seems to differ from *M. bouvieri* Desneux by the longer wings. Hagen's (1858) description of *T. debilis* gives 15 segments in the antennae. This species may be synonymous with Banks' description of *Eutermes debilis*, but Banks has confused two species in his figures, a *Microcerotermes* and a *Leucotermes*. *M. exiguus* Hagen is much smaller. *M. strunckii* (Sörensen) Silvestri is larger in nearly every measurement and the pronotum is conspicuously wider.

Soldier.—Head yellow, sometimes brownish, front darker, a brown spot behind the base of the antennae; clothed with a few bristles and hairs scattered over the head; somewhat oval, widest in back of the antennae, sides fairly straight, converging somewhat toward the rear.

Antennae with 13 segments, the 3d shorter than the 4th, the 4th shorter than the 2d.

Labrum relatively long, tip pointed.

Mandibles dark red brown, scimitar-shaped, the inner edges serrate.

Pronotum with the front margin somewhat emarginate. Legs pale.

Abdomen pale, tergites with short hairs and the posterior margin with a row of short erect bristles.

Measurements.—

Total length.....	4.00–5.00 mm.
Length of head.....	2.67–2.73 mm.
Width of head.....	.93–.97 mm.
Length of antennae.....	1.45–1.50 mm.
Width of pronotum.....	.58–.60 mm.
Length of hind tibia.....	.80–.83 mm.
Length of left mandible.....	1.27 mm.

Comparison with other species.—The figure of *M. strunckii* in Holmgren (1909), p. 88, shows the sides of the head straight.

Type locality.—Kartabo, British Guiana.

Other locality.—Trinidad.

Holotype.—Winged imago.

Morphotype.—Soldier.

The description is based upon several winged imagos and many soldiers, kings, and queens taken from seven different colonies at Kartabo. Several kings, queens and soldiers collected from six different colonies at Trinidad by the author agree with the Kartabo specimens.

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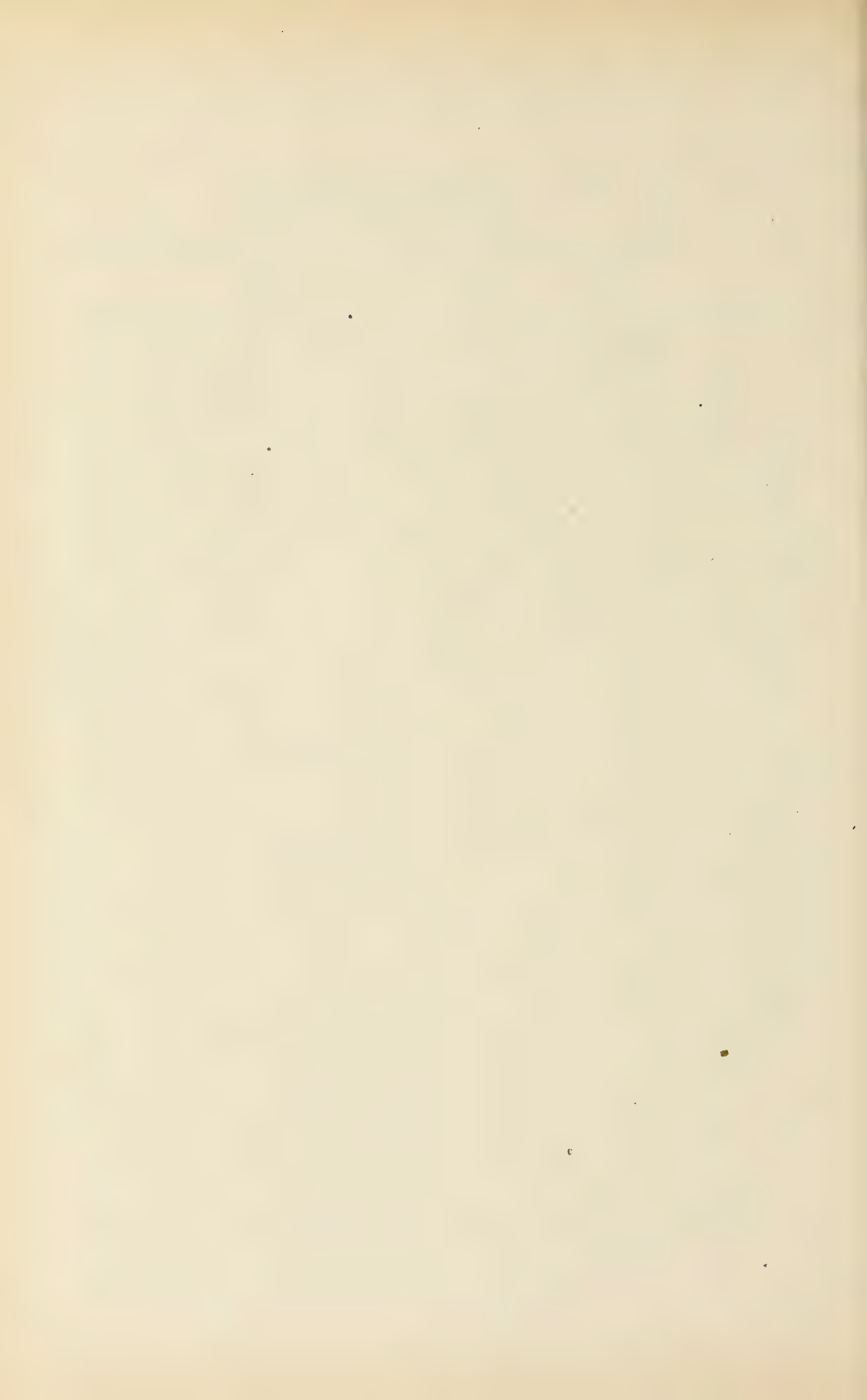
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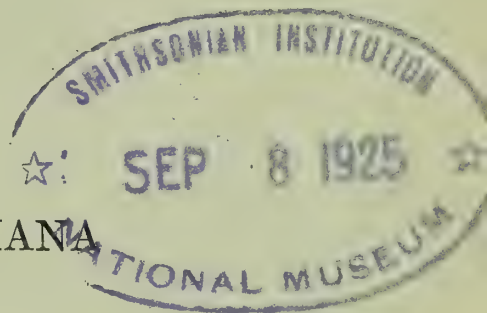


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THE ISOPODS OF KARTABO ☆
BARTICA DISTRICT, BRITISH GUIANA

BY WILLARD G. VAN NAME



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THE ISOPODS OF KARTABO¹*
BARTICA DISTRICT, BRITISH GUIANA

BY WILLARD G. VAN NAME

(Plates VII–XXVI incl.)

The American Museum of Natural History has received from William Beebe, Director of the New York Zoological Society's Tropical Research Station at Kartabo, British Guiana, a number of Crustacea of various groups collected in the course of the investigation of the fauna of the immediate vicinity of the Station. The Isopoda collected, comprising fourteen species and several additional specimens so immature that their certain determination is difficult, are described in the following pages. The collection is of special interest, as no less than six of them appear to be new to science, and because comparatively little has been recorded regarding the isopods of that part of South America, although it doubtless has a large representation of both land and aquatic isopods.

The following Isopoda are comprised in the collection:

Suborder CHELIFERA

Family TANAIDAE

Nototanais beebei, sp. nov.

Suborder FLABELLIFERA

Family EXCORALLANIDAE

**Excorallana berbicensis* Boone, 1918.

Family CYMOTHOIDAE

Livoneca symmetrica, sp. nov.

Livoneca guianensis, sp. nov.

Telotha henselii (von Martens), 1869.

Suborder EPICARIDEA

Family BOPYRIDAE

Probopyrus bithynis Richardson, 1904.

Suborder ONISCOIDEA

Family ONISCIDAE

Subfamily EUBELINAE

**Ethelum americanum* (Dollfus), 1896.

¹ Contribution from the Laboratory of the Department of Lower Invertebrates of the American Museum of Natural History, New York.

* Contribution, Department Tropical Research No. 194.

Subfamily ONISCINAE

Leptotrichus pittieri Pearse, 1921.

**Circoniscus gaigei* Pearse, 1917.

**Philoscia nitida*² (Miers), 1877.

*Philoscia maculata*² Budde-Lund, 1885.

Philoscia demerarae sp. nov.

Pentoniscus exilis, sp. nov.

Family LIGYDIDAE

Ligyda platycephala sp. nov.

Those of the above that have already been recorded from any part of Guiana (including the British, Dutch and French possessions) are indicated by an asterisk. The entire list of Isopoda hitherto recorded from that region comprises, as far as I am aware, only the following twenty-two species, eleven of which have been definitely credited to British Guiana. (See "Bibliography" at end of this article.) The present article raises these numbers to thirty-two from the whole of Guiana and twenty-two from British Guiana.

ISOPODS ALREADY RECORDED FROM GUIANA.

Suborder FLABELLIFERA

Family EXCORALLANIDAE

Excorallana berbicensis Boone, 1918.

Excorallana berbicensis Boone, 1918, *Proc. U. S. Nat. Mus.*, LIV, p. 594 pl. XCII, fig. 1.

Locality.—Rio Berbice, British Guiana.

Represented also in the present collection from Kartabo.

Family CYMOTHOIDAE

Livoneca redmanni Leach, 1818.

Livoneca redmanni + *L. desmarestii* Leach, 1818, *Dict. Hist. Nat.* XII, p. 352; Desmarest, 1825, *Con. gen. Crust.*, p. 308; Milne-Edwards, 1840, *Hist. Nat. Crust.*, III, p. 261; also in Cuvier, *Regn. Anim.* III, pl. LXVI, figs. 3-3e, 4-4a.

Livoneca redmanni Schioedte and Meinert (part), 1884, *Nat. Tidsskr.* (3) XIV, p. 353, pl. XIV, figs. 6-12; Richardson, 1900, *Amer. Naturalist*, XXXIV, p. 221; 1901, *Proc. U. S. Nat. Mus.*, XXIII, p. 531; 1905, *Bull.* 54, *U. S. Nat. Mus.*, p. 261, figs. 274, 275.

Locality.—Guiana (Schioedte and Meinert); also West Indies and Brazil

Suborder ONISCOIDEA

Family ONISCIDAE

Philoscia spinosa, Say, 1818.

Philoscia spinosa Say, 1818, *Journ. Acad. Nat. Sci. Philadelphia*, I, p.

² Identification somewhat uncertain owing to the insufficient description.

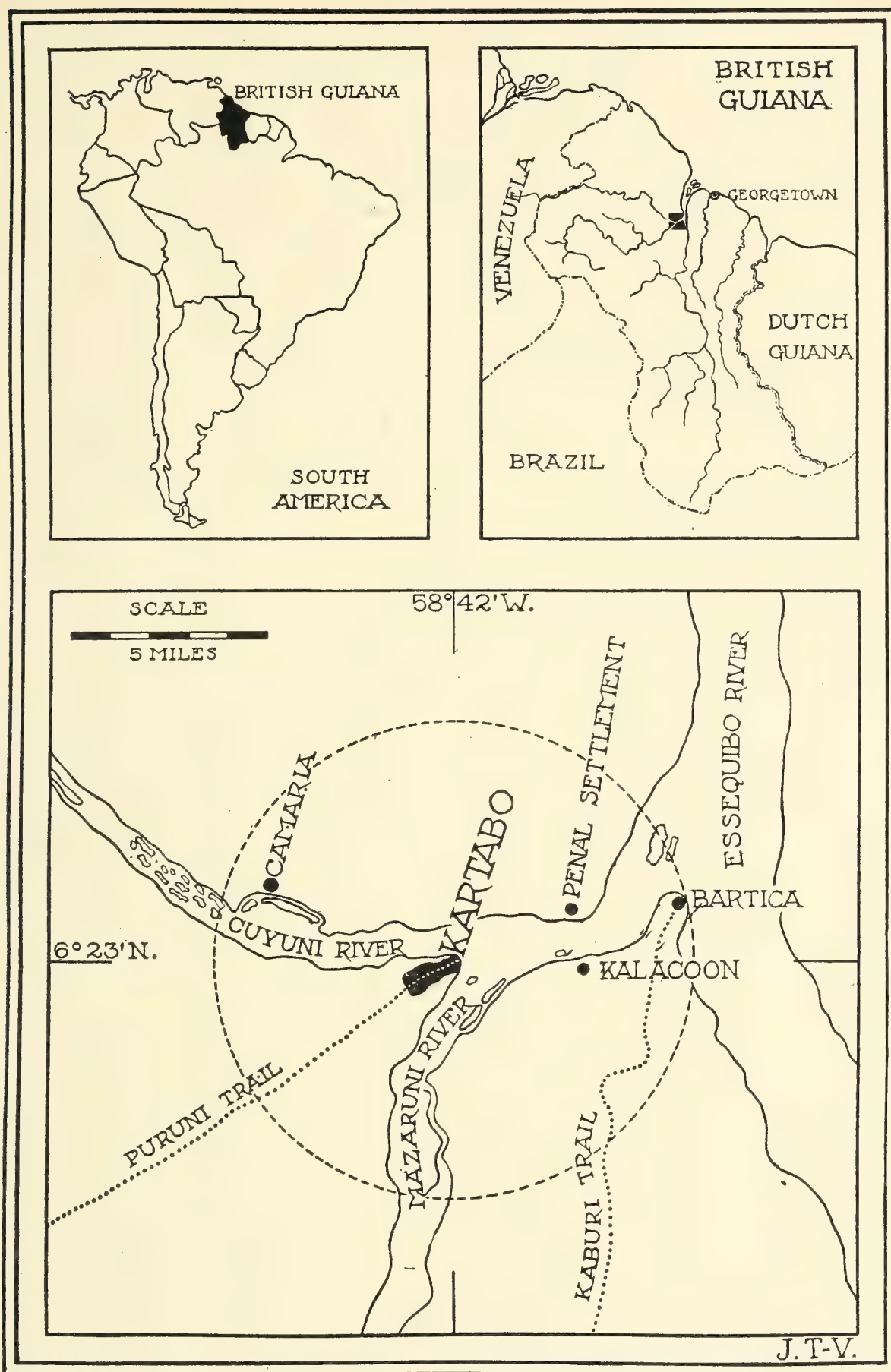


Plate A. British Guiana Tropical Research Station of the New York Zoological Society.
Circle represents a radius of six miles.

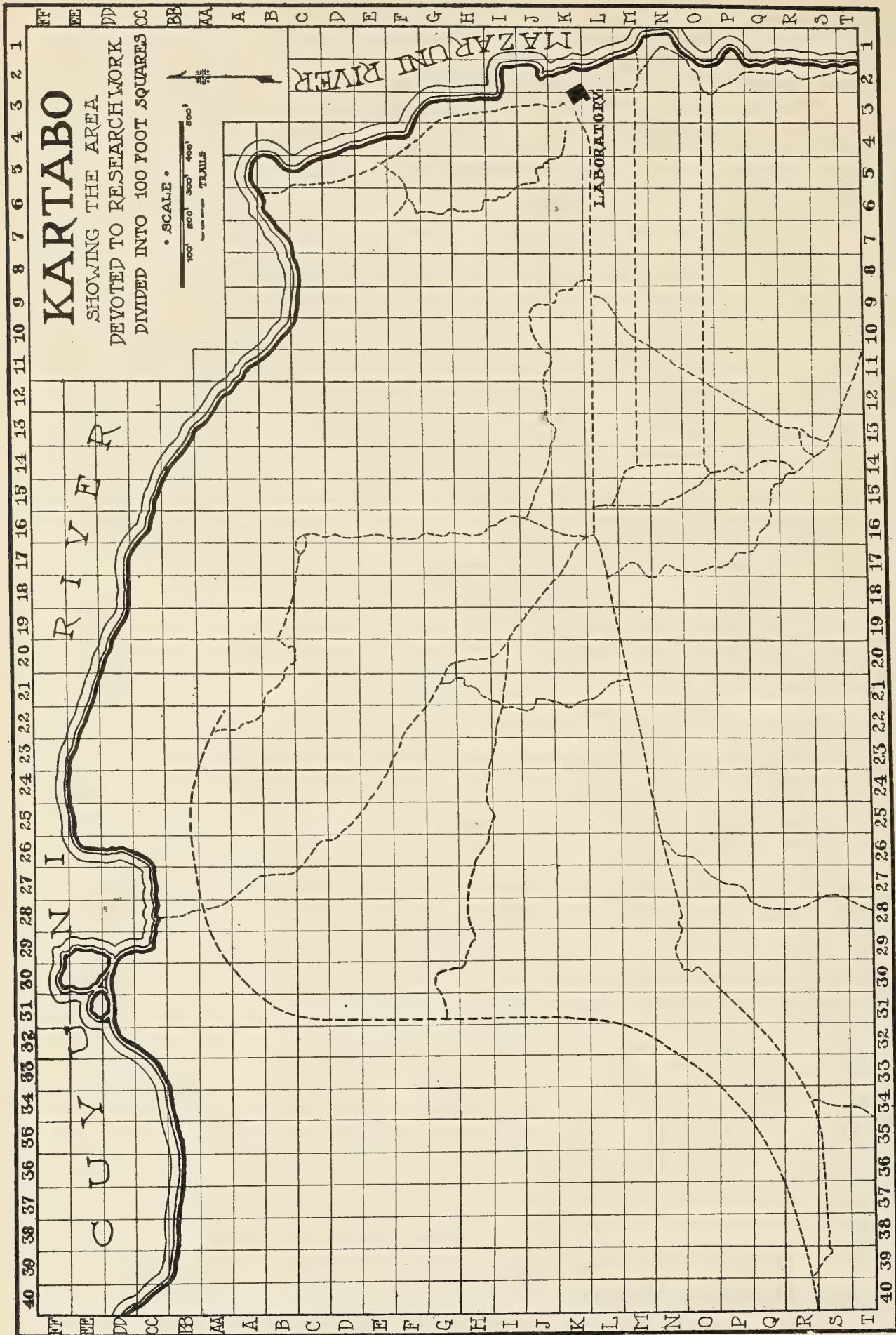


Plate B. Area devoted to research at Kartabo.

Drawing by John Tee-Van.

429; Pearse, 1917, *Occ. Papers Mus. Zool. Univ. Michigan*, No. 46, p. 7.
For other references, see Richardson, 1905, p. 608, and Budde-Lund, 1885, p. 223.

Locality.—Savannah, Georgia (Say, 1818); Dunoon, British Guiana, "from wet rotten logs in clay jungle, and rotten wood on ground in the Labba Creek sandhills" (Pearse, 1917).

Philoscia olfersii Brandt, 1833.

Philoscia olfersii Brandt, 1833, *Consp. Monogr. Crust. Onisc.*, p. 21;
Budde-Lund, 1885, *Crust. Isop. Terr.*, p. 212; Pearse, 1917, *Occ. Papers, Mus. Zool. Univ. Michigan*, No. 46, p. 7.

For other references see Budde-Lund, 1885.

Locality.—Brazil (Brandt); Dunoon, British Guiana. "In wet rotten logs and under fallen leaves" (Pearse, 1917).

Philoscia nitida (Miers), 1877.

Philougria nitida Miers, 1877, *Proc. Zool. Soc. London*, ann. 1877, p. 670, pl. LXIX, figs. 3-3b.

Philoscia nitida Pearse, 1915, *Proc. U. S. Nat. Mus.*, LXIX, p. 542.

Locality.—"Peru; Guiana. The specimens from Guiana generally appear rather more coarsely granulated" (Miers, 1877). Santa Marta region, Colombia (Pearse, 1915). "This was an abundant species in the forest from 'La Rosa' to the top of San Lorenzo [8000 feet]. It was usually found on the ground among leaves or under logs, but was also taken on tree trunks, in brooks and in bromeliads. At the top of San Lorenzo it was found in the ground under leaves and in a little brook that started there. Those taken at high altitudes are darker in color in alcohol" (Pearse, 1915).

Specimens in the present collection from Kartabo appear to belong to this species.

Porcellionides brunneus (Brandt), 1833.

Procellio brunneus Brandt, 1833, *Bull. Soc. Imp. Nat. Moscou*, VI, p. 176.

Milne Edwards, 1840, *Hist. Nat. Crust.*, III, p. 172. Stuxberg, 1875, *Ofvers. k. svensk. Vetensk. Akad. Forh.*, XXXII, No. 2, p. 43.

Metoponorthus brunneus Budde-Lund, 1885, *Crust. Isop. Terr.*, p. 171.

Locality.—Demerara.

Porcellionides pruinosus (Brandt), 1833.

? *Porcellio* (*Porcellionides*) *jelskii* Miers, 1877, *Proc. Zool. Soc. London*, 1877, p. 668, pl. LXVIII, figs. 3-3b.

Porcellio (*Porcellionides*) *flavovittatus* Miers, 1877, *Proc. Zool. Soc. London*, 1877, p. 669, pl. LXVIII, figs. 4-4b.

Metoponorthus pruinosus Budde-Lund, 1885, *Crust. Isop. Terr.*, p. 169; Richardson, 1901, *Proc. U. S. Nat. Mus.*, XXIII, p. 569; 1905, *Bull. 54, U. S. Nat. Mus.*, p. 627, fig. 674.

See Budde-Lund, 1885, and Richardson, 1905, for synonyms.

Localities.—Cayenne (*P. flavo-vittata* Miers, 1877); Peru and Guiana (*P. jelskii* Miers, 1877). This species is of practically world-wide distribution.

Porcellionides jelskii (Miers), 1877.

Porcellio (*Porcellionides*) *jelskii* Miers, 1877, *Proc. Zool. Soc. London*, 1877, p. 668, pl. LXVIII, figs. 3-3b.

Richardson (1905, p. 621) makes this a doubtful synonym of *P. pruinosus* (see above).

Porcellio cayennensis Miers, 1877.

Porcellio cayennensis Miers, 1877, *Proc. Zool. Soc. London*, 1877, p. 667, pl. LXVIII, figs. 2-2b.

Locality.—Cayenne.

Lyprobius cristatus (Dollfus), 1889.

Porcellio cristatus Dollfus, 1889, *Notes Leyden Mus.*, XI, p. 91, pl. V, figs. 2-2d.

Lyprobius cristatus Budde-Lund, 1893, *Ent. Meddel.*, ann. 1893, p. 127; Dollfus, 1892, *Ann. Soc. Ent. France*, LXII, p. 345.

Locality.—Surinam (Dollfus); Caracas, Venezuela (Budde-Lund).

Leptotrichus emarginatus Pearse, 1917.

Leptotrichus emarginatus Pearse, 1917, *Occ. Papers Zool. Mus. Univ. Michigan*, No. 46, p. 5.

Locality.—Dunoon, British Guiana. Taken under bark of trees, in axils of leaves three to ten feet from the ground, and also in loose sand (Pearse).

Cubaris murina Brandt, 1833.

Cubaris murina + *C. brunnea* Brandt, 1833, *Bull. Soc. Imp. Nat. Moscou*, VI, p. 28.

Armadillo murinus + *A. brunneus* Milne-Edwards, 1840, *Hist. Nat. Crust.*, III, p. 179.

Cubaris murinus + *C. brunneus* Stuxberg, 1875, *Öfvers. k. svensk. Vetensk.-Ak. Forh.* XXXII, No. 2, p. 44 (foot-note).

Cubaris affinis Miers, 1877 (non Dana, 1854), *Proc. Zool., Soc. London*, ann. 1877, p. 666, pl. LXVII, figs. 4-4b.

Armadillo murinus Budde-Lund, 1879, *Prosp. Isop. Terr.*, p. 7; 1885, *Crust. Isop. Terr.*, p. 27; 1904, *Rev. Crust. Isop. Terr.*, part III, p. 119.

Cubaris murina Richardson, 1901, *Proc. U. S. Nat. Mus.*, XXIII, p. 571; 1905, *Bull.* 54, *U. S. Nat. Mus.*, p. 645, figs. 687-689.

See Budde-Lund, 1885, and Richardson, 1905, for other synonyms.

Localities.—Demerara (Brandt, 1833); Cayenne (Miers, 1877). Widely distributed in the tropics.

Cubaris gaigei Pearse, 1917.

Cubaris gaigei Pearse, 1917, *Occ. Papers Zool. Mus. Univ. Michigan*, No. 46, p. 2, fig. 1.

Locality.—Dunoon, British Guiana. In rotten logs and under dead leaves on the ground, and on trees under loose bark, among bromeliads, etc. (Pearse)

Sphaeroniscus portoricensis Richardson, 1901.

Sphaeroniscus portoricensis Richardson, 1901, *Proc. U. S. Nat. Mus.*, XXIII, p. 573, fig. 34; 1905, *Bull.* 54, *U. S. Nat. Mus.*, p. 662, figs. 703,

704. Pearse, 1917, *Occ. Papers Zool. Mus. Univ. Michigan*, No. 46, p. 3.

Locality.—Dunoon, British Guiana, on sand hills and in an abandoned termite nest (Pearse); El Yunque, Porto Rico (Richardson).

Circoniscus spinosus (Collinge), 1918.

Paracubaris spinosus Collinge, *Journ. Linn. Soc. London, Zool.*, XXXIV, p. 61, pl. VI.

Locality.—Mazakuri River, British Guiana, in decaying wood.

Though made the type of a new genus (*Paracubaris*) by Collinge, this

species is apparently hardly separable generically from *Circoniscus* Pearse, 1917, to which I am accordingly referring it.

Circoniscus gaigei Pearse, 1917.

Circoniscus gaigei Pearse, 1917, *Occ. Papers Mus. Zool. Univ. Michigan*, No. 46, p. 4, fig. 2.

Locality.—Dunoon, British Guiana, in rotten logs, under bark of trees, etc. (Pearse).

Represented also in the present collection from Kartabo.

Eluma caelatum (Miers), 1877.

Armadillidium caelatum Miers, 1877, *Proc. Zool. Soc. London*, 1877, p. 665, pl. LXVII, figs. 3–3b.

Eluma purpurascens Budde-Lund, 1879, *Pros. Isop. Terr.*, p. 6; 1885, *Crust. Isop. Terr.*, p. 48., Dollfus, 1896, *C.-R. 3me Congres. Int. Zool. Leyden*, p. 357.

Eluma caelatum Collinge, 1917, *Check-list British Terr. Isop.*, p. 115; 1922, *Journ. Linn. Soc. London, Zool.*, XXXV, p. 105, pl. VIII.

See Collinge, 1922, for synonyms and discussion.

Locality.—Cayenne (Miers, 1877; Budde-Lund, 1885; Dollfus, 1896). Also in Spain, Algeria, Madeira, etc. This species is the type of the genus *Eluma*, established for it by Budde-Lund (1885, p. 48).

Armadillidium vulgare (Latreille), 1804.

Armadillo vulgaris Miers, 1877, *Proc. Zool. Soc. London*, 1877, p. 665.

Armadillidium vulgare Budde-Lund, 1885, *Crust. Isop. Terr.*, p. 66;

Richardson, 1905, *Bull. 54, U. S. Nat. Mus.*, p. 666, fig. 706.

See Budde-Lunde, 1885, and Richardson, 1905, for synonyms.

Locality.—Cayenne (Miers), 1877. This locality was given doubtfully by Miers, but does not seem unlikely, as the species is almost cosmopolitan.

Ethelum americanum (Dollfus), 1895.

Mesarmadillo americanus Dollfus, 1896, *Proc. Zool. Soc. London*, 1896 pp. 397, 398.

Ethelum americanum Pearse, 1917, *Occ. Papers Mus. Zool. Univ. Michigan*, No. 46, p. 1.

For other references see descriptive part of this paper.

Locality.—St. Vincent, W. I. (Dollfus); Dunoon, British Guiana. On trees among bromeliad roots, vines, etc. (Pearse, 1917). Represented also in the present collection from Kartabo.

Family LIGYDIDAE

Ligyda exotica (Roux), 1828.

Ligia exotica Roux, 1828, *Crust. Medit.*, p. 3, pl. XIII, fig. 9; Richardson, 1902, *Trans. Conn. Acad. Sci.*, XI, p. 306.

Ligia baudiniana ? (non Milne-Edwards, 1840) Miers, 1877, *Proc. Zool. Soc. London*, ann. 1877, p. 670.

Ligyda exotica Richardson, 1905, *Bull. 54, U. S. Nat. Mus.*, p. 676, figs. 716–718; Van Name, 1918, *Bull. Amer. Mus. Nat. Hist.*, XLIII, p. 72, figs. 27–30.

See Van Name, 1918, for synonyms.

This species is found on the shores of most tropical regions of both hemi-

spheres. Richardson (1902) points out that the descriptions of the specimens from "Cayenne" doubtfully assigned by Miers, 1877, to *L. baudiniana*, agree somewhat better with the present species. In a later work (1905) however, she omits Cayenne from the localities given for *L. exotica*, though she credits *L. baudiniana* to that locality. It is likely that both species occur in Guiana.

Ligyda baudiniana (Milne-Edwards), 1840.

Ligia baudiniana Milne-Edwards, 1840, *Hist. Nat. Crust.*, III, p. 155.

Ligia gracilis Moore, 1902, *Bull. U. S. Comm. Fish and Fisheries*, XX, pt. 2, p. 175, pl. XI, figs. 7-12.

Ligyda baudiniana Richardson, 1905, *Bull. 54, U. S. Nat. Mus.*, p. 678, figs. 719-723.

See Richardson, 1905, for synonyms.

Locality.—Cayenne, Miers, 1877 (?); Richardson, 1905, See remarks under *L. exotica*.

Ligyda cajennensis (Koch), 1847.

Ligia cajennensis Koch, 1847, *Syst. Myriapod.*, p. 212, pl. IX, fig. 102;

Budde-Lund, 1885, *Crust. Isop. Terr.*, p. 271; Jackson, 1922, *Proc. Zool. Soc. London*, 1922, pp. 698, 701.

Ligia cajennensis Stuxberg, 1875, *Öfvers. k. svensk. Vetensk.-Ak. Forh.*, XXXII, No. 2, p. 43.

Locality.—Cayenne.

Of the fourteen species of isopods collected at Kartabo, six are aquatic and eight are terrestrial forms. Although the water of the rivers is entirely fresh at that point, the close relationship of the aquatic forms to marine species is worthy of note. *Nototanais beebei* fits fairly well into a genus of the sub-antarctic seas, several species having been described from that region of the world, of which *N. dimorphus* (Beddard), 1886, (syns. *Paratanais d.* Beddard 1886, *Rep. Voy. Challenger*, Zool., XVII, p. 130, Pl. XVII, figs. 1-8; *Nototanais australis* Richardson, *Exped. Ant. Franç.*, 1903-1905, *Isopodes*, Mém. 2, p. 1 fig. 1; *Nototanais d.* Vanhoeffen, *Deutsch. Südpol.-Exped.*, XV, p. 470) seems to be the closest to *N. beebei*. It was originally collected by the *Challenger* Expedition off Kerguelen Island in rather deep water, and has been since found in other sub-antarctic localities.

Excorallana and *Livoneca* are genera whose species are mainly marine; they are predaceous forms that attach themselves to fishes, which has no doubt contributed toward the extension into fresh water of certain of their species. *Telotha* is represented by two species in South American rivers, but is very closely related to, and perhaps derived from the same immediate ancestors as *Cymothoa*, widely distributed in the sea. This genus is likewise parasitic on fishes. The remaining aquatic genus, *Probopyrus*, is also unquestionably one of marine origin, some of its species being parasites on strictly marine species of shrimps.

Moreover one of the terrestrial forms (*Ligyda*) belongs to a genus whose most familiar species are inhabitants of the sea coasts, living on wet rocks piles of wharves, etc. at the water's edge, but in this case we may feel uncertain as to whether such littoral habits are not merely a recent acquirement of certain species.

DESCRIPTIONS OF SPECIES

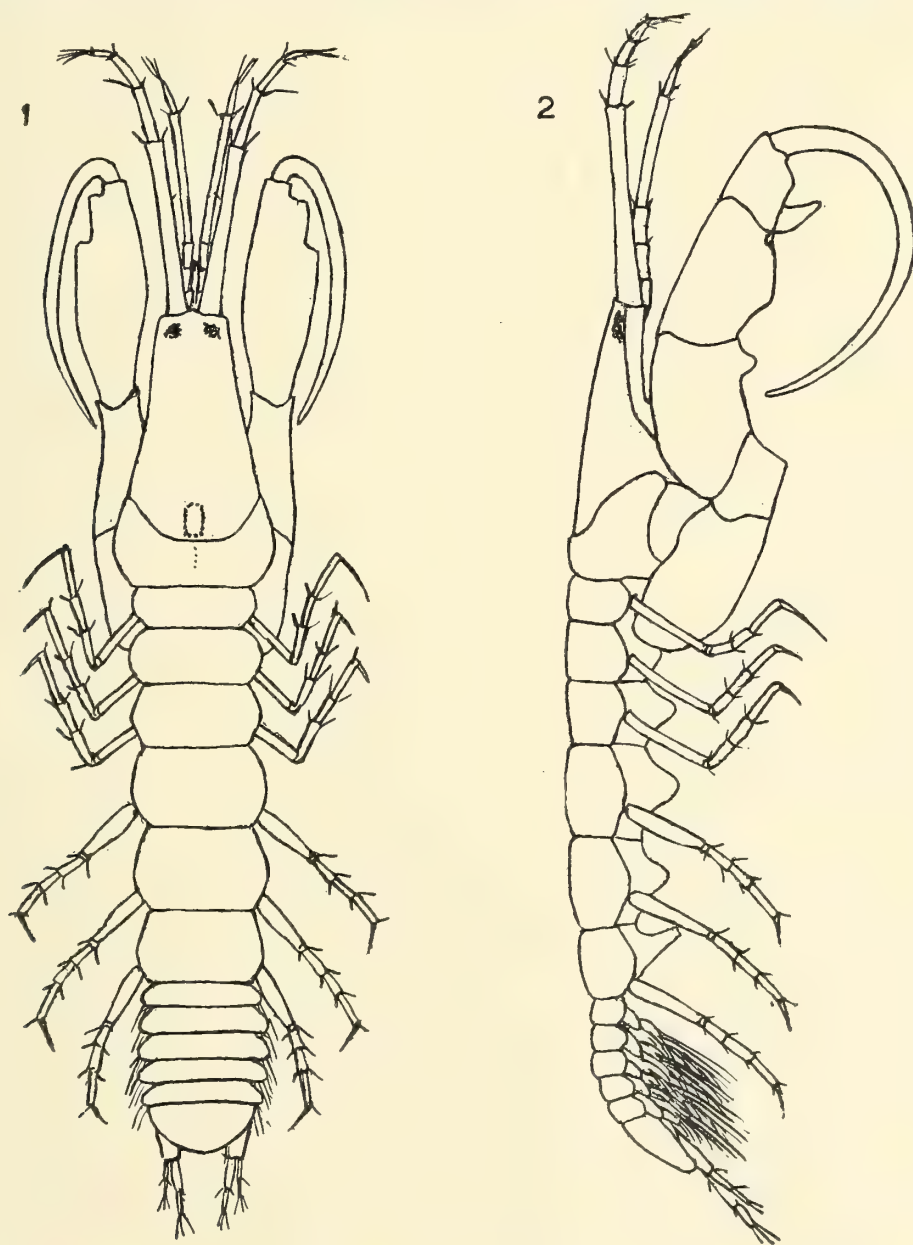
Suborder CHELIFERA

Family TANAIIDAE

Nototanaïs beebei, sp. nov.

(Plate VII, figs. 1-2)

Five specimens of this species were collected; three of them are in a very poor condition for study, as they are rolled up in a small circle (the dorsal surface outside), the large chelae being extended out at right angles, showing a degree of mobility in these limbs which one would hardly expect from their compact articulation. The other two specimens are straightened out, or nearly so, and the following description and figures have been based chiefly on these two. All

Plate VII.—1-2, *Nototanaïs beebei*, sp. nov. × about 40.

the five specimens are apparently males, and we may expect the females to have smaller and simpler chelae and probably but three segments in the first antennae.

Body elongate; the average width is contained six or seven times in the length. Back flattened, the segments being only slightly arched from side to side. All the segments are free and separately movable except the first thoracic segment, which is immovably united with the head. The specimens do not vary greatly in size; the largest do not much exceed 2 mm. in length. The alcoholic specimens are of the usual yellowish color.

Head very elongate (over one-quarter of the total body length), its posterior end wide and rounded, and deeply set back into the first thoracic segment; its sides converge gradually toward the rather narrow front end, which is truncate and has a slight median projection. Eyes represented by two pigmented areas on the upper surface at the extreme front end of the head. First antennae stout, of five segments; the basal one being very long, the terminal one minute; second antennae smaller and shorter, also of five segments, the three first short, the fourth very long; the second segment bearing a spine or scale on the median side at its distal end. The upper surface of the head is fairly smooth and even except for an oval depression on the median line near the posterior border.

The first thoracic segment is the widest part of the body and bears the enormous chelae which terminate in a long recurved scythe-like dactylus. The lower border of these chelae presents several teeth or projections, notably a long, triangular downwardly and distally directed one near the end of the propodus. Their superior border is evenly curved.

In strong contrast to their flattened dorsal surfaces, the thoracic segments (especially toward the posterior end of the body) have their median ventral region produced downward into a keel-like projection. On the seventh segment this is long and more or less terete, and has an obliquely forward and downward direction. Except the first, the thoracic segments are of nearly uniform width, though varying greatly in length, the fifth, sixth and seventh being the longest; the abdominal segments are equally wide but all very short except the telson, which is broadly rounded behind. The thoracic legs are long, weak and slender; the first pair behind the chelae have the terminal claw much longer than the others, and the last three legs are somewhat stouter than those in front. The pleopoda are developed on all the five first segments of the abdomen. They are short, and bear an abundance of long swimming hairs. The uropoda each consist of a short basal segment which reaches a little beyond the telson and two terete branches, the inner of which is longer and stouter, though so far as I could demonstrate, they both consist of two segments.

The collection comprises five specimens, (original collector's number 22497), from Kartabo, British Guiana. These were all taken from the stomach of a six-inch cat-fish, *Pimelodus clarias* (Bloch). Its nearest ally seems to be *N. dimorphus* (Beddard), 1886, as noted in the introductory part of this article. The species is named for William Beebe, Director of the Tropical Research Station.

Suborder FLABELLIFERA

Family EXCORALLANIDAE

Excorallana berbicensis Boone, 1918.

Excorallana berbicensis Boone, 1918, *Proc. U. S. Nat. Mus.*, LIV, p. 594, pl. XCII, fig. 1.

(Plate VIII, figs. 3-8 incl.)

The collection contains two specimens, a female 7.8 mm. long and a male 6 mm. long, which I refer to this species. The original description was based on two specimens, apparently both females. The discovery of the male shows that it is a species very closely related to *E. tricornis* (Hansen), 1890, known from the West Indian region, and represented, according to Richardson, 1905, p. 141, by a subspecies (*occidentalis*) in the Gulf of California. From that species it is however at once distinguished by the absence of incisions in the sides of the tapering part of the telson, and in the female apparently also by the entirely smooth upper surface of the head. In the male the head bears an anterior median process or prominent tubercle, and a pair of somewhat smaller ones between the eyes as in *E. tricornis*, and the surface of the head within the triangle thus formed is depressed or concave.

Body rather elongate, more so in the female, where the greatest width is contained over three times in the length, than in the male, where it is contained about two and three-quarters times. In the male specimen the first thoracic segment is considerably longer, and the fifth, sixth, and seventh considerably shorter than the rest; in the female not only are the individual thoracic segments, except the first, proportionately longer on the median line and narrower, but only the seventh is conspicuously shorter. The first three have the posterior lateral angles rounded off; the last four have them sharp and extended backward to an increasing degree as the rear end is approached. Articulation firm; body surface for the most part hard and smooth, except for a minute irregular pitting visible only on considerable magnification. The last two or three thoracic and the third and fourth abdominal segments bear a row of small tubercles near the posterior edge, also a few short backwardly directed hairs. The fifth abdominal segment bears four tubercles along the posterior border; the telson has two pairs of small ones on the anterior part (two near the middle and two near the bases of the uropoda). These tubercles, which are all small, are more conspicuous in the male specimen, though present in both sexes. Legs of the first three pairs stout and provided with prehensile claws. The merus of the first pair bears on its lower outer aspect a row of five blunt tubercles. On the succeeding pair there are four of these tubercles (the middle one of the row being wanting); on the third pair but three. This is the condition in both the male and female specimens. The fourth to seventh legs are elongate, slender and not prehensile.

The head is narrow and rounded in front except for a small median process. The eyes are large with about eight horizontal rows of ocelli, with eight ocelli in the longest rows. The first antennae meet at the median line and form the extreme front outline of the head; they have ten articles in the flagellum, the first being very short and the second (in the female specimen, also the third)

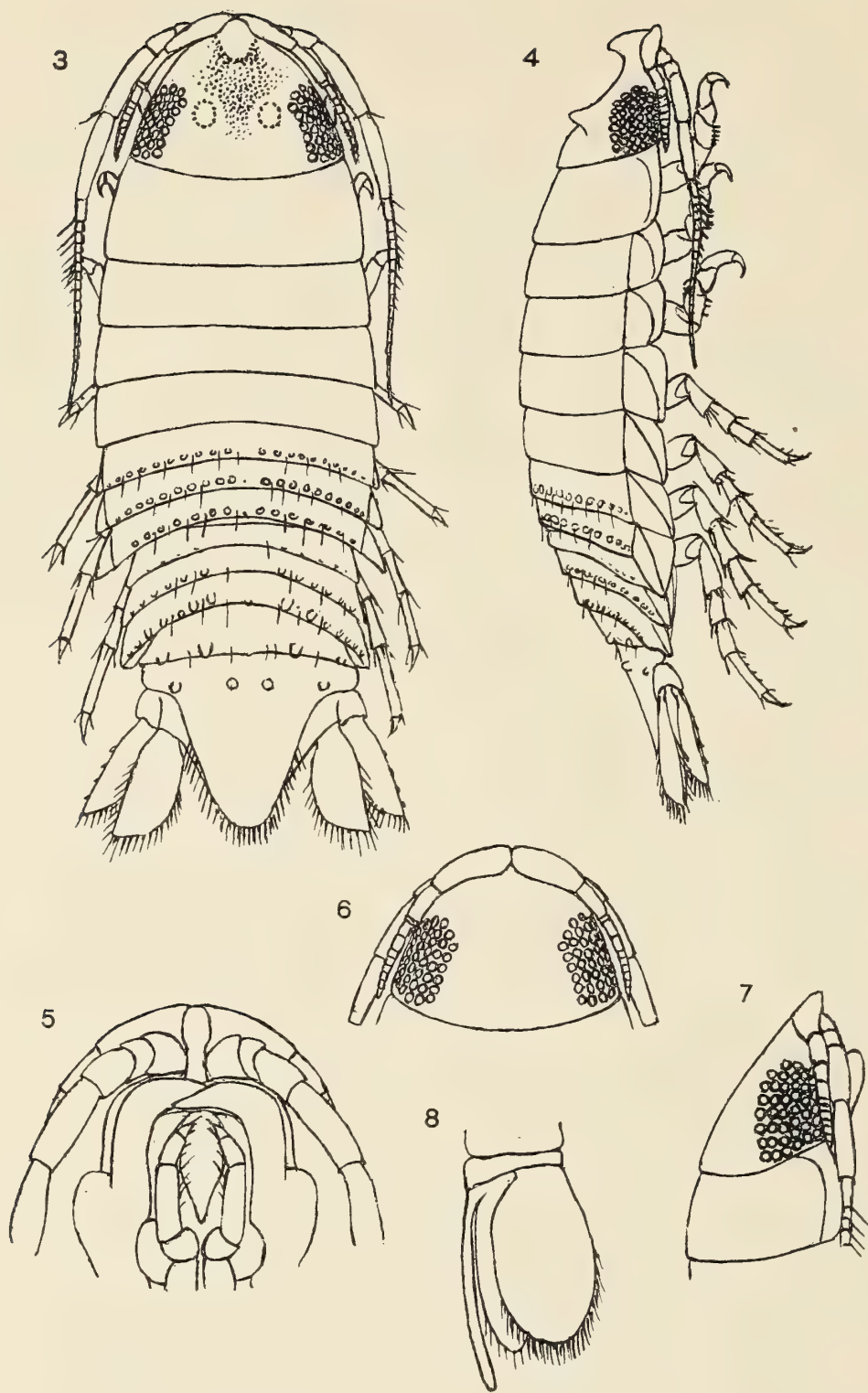


Plate VIII.—*Excorallana berbicensis* Boone, 1918; 3, and 4, male $\times 13.5$; 5, ventral aspect of head of female $\times 19$; 6 and 7, dorsal and lateral aspects of head of female $\times 14$; 8, second abdominal appendage of male $\times 22$.

article being somewhat elongated. They reach, when drawn back, a little way beyond the rear border of the head. The second antennae have the three basal joints short and the fourth and fifth long, the flagellum has eighteen to twenty articles of which the first is more elongated than the succeeding ones; they reach, when well drawn back, along the fourth thoracic segment to about its middle. They are a little slenderer in the female than in the male.

The abdomen is wide; its first segment is practically covered by the seventh thoracic; the fifth has its lateral ends covered by the backwardly produced ends of the fourth. The second pleopoda of the male bear a slender blunt-ended styloid process longer than the foliaceous parts of the appendage. The terminal half of the telson and the branches of the uropoda, except the outer edge of the outer branch, are fringed with hairs. The inner branches are wide; the outer narrow, and both have the ends obliquely truncated.

The two specimens described above are both inferior in size to Miss Boone's type from the Rio Berbice, British Guiana, which measured 13 mm. by 4 mm. They were both collected at Kartabo, British Guiana, by William Beebe (collector's number of male 221104, of female 22364). The male was taken from the gills and the female from the pectoral fin of different specimens of *Lycengraulis grossideus* (Cuvier).

Family CYMOTHOIDAE

Livoneca symmetrica, sp. nov.

(Plate IX-X, figs. 9-14 incl.)

The six adult specimens in the collection range from 20.6 to 17 mm. long. All but two are females with large marsupial plates forming a large well distended marsupium. The two others, though lacking the marsupial plates, are quite similar to the rest in other respects and are apparently also females. The body surface is very slightly rough, pale yellowish in color, and bears minute scattered spots of blackish pigment.

The head in a dorsal view is gently rounded in front and behind with straight sides converging toward the front. It is scarcely at all set back into the thorax, though the first segment of the latter is produced forward a little way into a small lobe of rounded-triangular shape at each of the forward corners. The eyes are rounded-oblong in outline, of fair size, and well pigmented. The front of the head is somewhat bent down over the bases of the antennae. The antennae of the two sides arise well apart. The first pair is the stoutest, and is eight-jointed. The second pair is more slender and a little longer and is nine-jointed. The form of the thoracic segments and their epimera are sufficiently shown in the figures here given. The legs are fairly long, but the thighs are not expanded or provided with a keel. The dactyli are strongly hooked and increase in length from the first to the sixth pair; those of the seventh pair are smaller even than those of the first. The abdomen is wide and slightly diminishes in width toward the rear. It is deeply set into the thorax, and the lateral ends of all its segments except the first (which, however, is of the full width), are bent backward and pointed. The telson is wide and strongly arched, and has the posterior outline slightly produced, forming an obtuse median angle. The

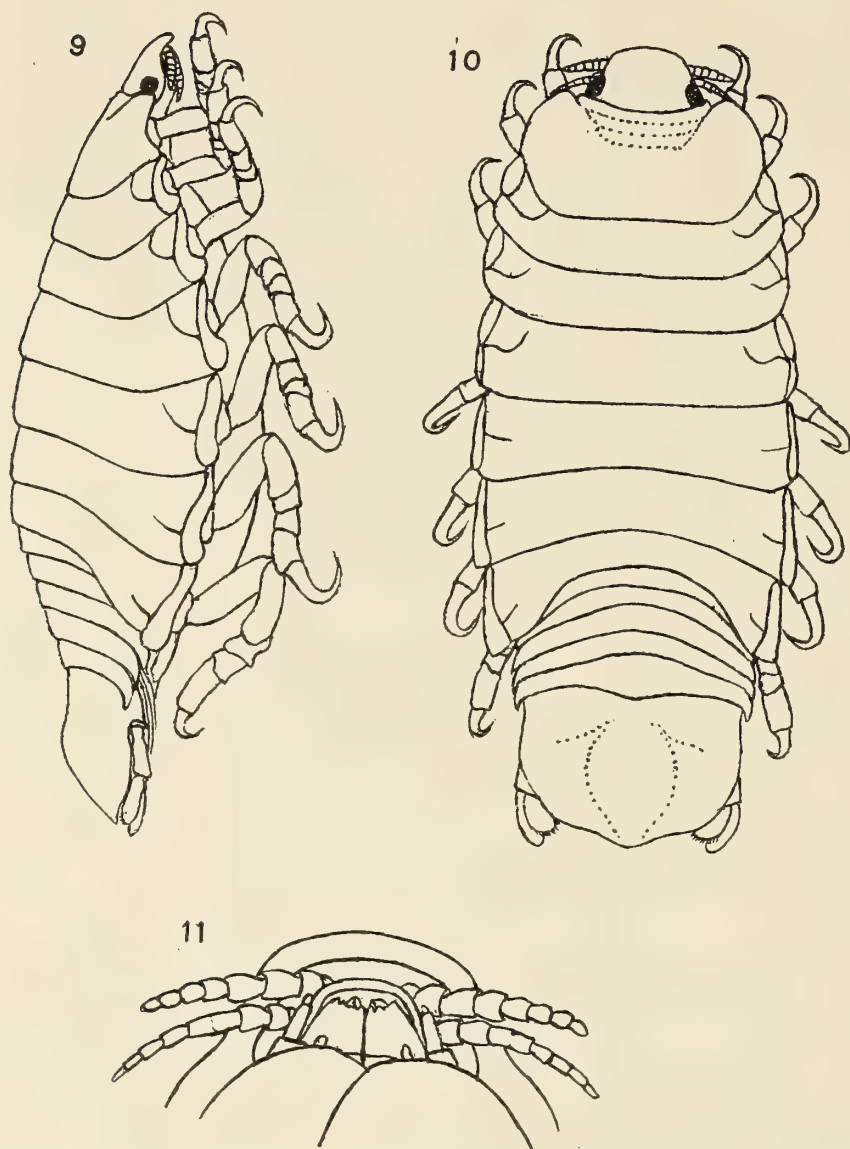


Plate IX.—*Livoneca symmetrica*, sp. nov.: 9 and 10, female $\times 4$; 11, ventral aspect of head same $\times 12$.

uropoda reach to or slightly beyond its end; the outer branch is slightly falcate, the inner is shorter and oval. Both are rounded at the end.

A larval individual (fig. 12) from the marsupium of one of the adults is about 3.6 mm. long and differs much from the adult, not only in the proportionately larger and longer abdomen and telson, but in the very much greater length of the head, which is produced in triangular form anterior to the eyes to a remarkable extent. The upper parts bear more blackish pigmentation than the adults have; this is distributed chiefly in rather narrow median and lateral stripes (one on each side) and in thin, broken transverse lines on the thoracic and abdominal segments. The eyes are larger and more deeply pigmented than in the adult, and the antennae, though having the same number of segments, are proportionately longer. The seventh pair of legs are not yet developed and the corresponding thoracic segment is very short and small. The other legs are long and all have strong hooked dactyli, those of the anterior legs being the largest. The propodus of all the legs is somewhat widened and flattened, but is without spines; the dactyli are not denticulated.

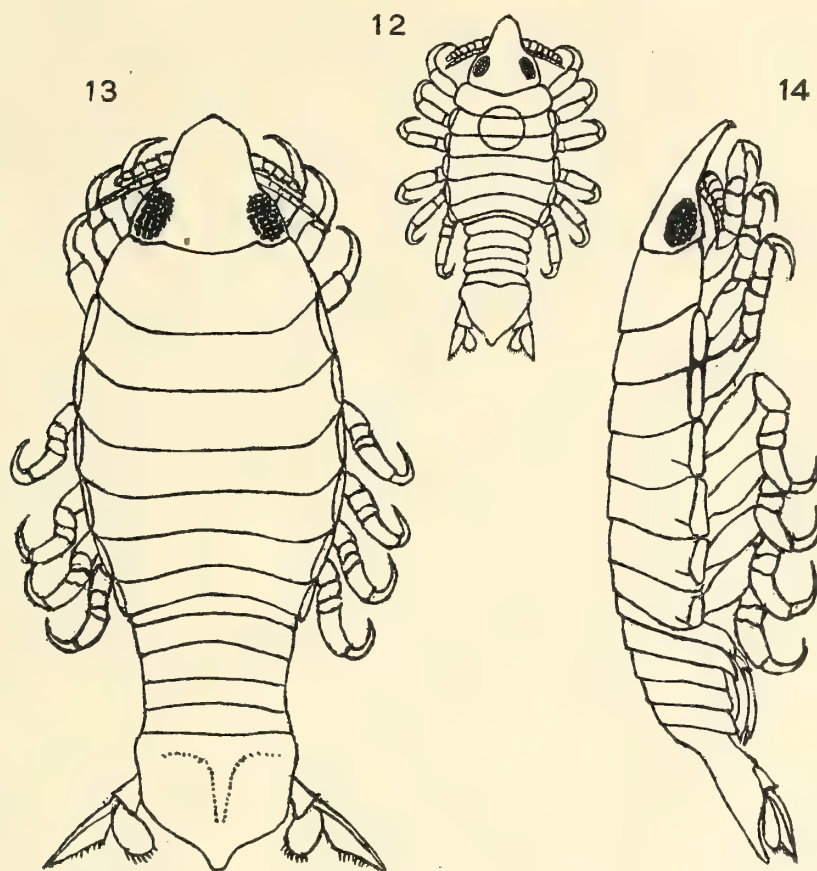


Plate X.—*Livoneca symmetrica*, sp. nov. Young stages; 12, larval individual 3.6 mm. long from marsupium of adult; 13 and 14, young individual 8.5 mm. long.

Schioedte and Meinert (1884) include in the genus *Livoneca* species (*L. indica* and *L. sinuata*) having the propodus of the legs of the larva without spines as in this form; in most species of *Livoneca*, when the larva is known, the propodus bears a row of spines. I am inclined to suspect that this is a character upon which not only the species of *Livoneca* but those placed by the above authors in various allied genera might well be rearranged, but this must await a knowledge of the larval forms of more members of this group. The fact that information regarding this character is available in the case of so few species makes it seem premature to place this species elsewhere than in *Livoneca*, though it is far from being a typical example of that genus.

The young individuals of this stage all bear a foetal character in the form of a definitely circumscribed circular swelling or raised area, whose surface is finely granular when dry, on the median part of the back. Its center is on the second thoracic segment, but it encroaches also on the first and third segments. Another foetal character is that the ventral region of the body is still distended by a considerable quantity of yolk.

What I believe to be a slightly later stage of this same species is represented by an individual about 4.2 mm. long, taken from a young cichlid fish (*Cichla ocellaris*). The body is more flattened than in the stage just described, the yolk has disappeared and the seventh legs are present though not fully developed. In the specimen shown in figs. 13 and 14 and which is 8.5 mm.

long, representing, I believe, still another stage in the development of this species, the seventh legs are well developed.

The specimens of this species bear the following collector's numbers and data:

221077—Female with empty marsupium from the gills of *Myloplus rubripennis*, Sept. 4, 1922. Type.

22440—Female with 28 large larvae in marsupium from Perai fish, *Serrasalmo rhombeus* Linnaeus, July 22, 1922.

2412—Four adults (two with marsupium which in one case contained large larvae) from giant catfish or Lau-lau (*Brachyplatystoma* sp.), March 4, 1924.

201529—Two larvae like fig. 12, probably from the marsupium of an adult.

221007—Young individual, shown in figs. 13 and 14, from the scales of the catfish *Hemidorus carinatus* (Linnaeus).

24485—Very young individual 4.2 mm. long taken from a young Lucananni fish, *Cichla ocellaris* Bloch and Schneider, May 4, 1924.

***Livoneca guianensis*, sp. nov.**

(Plates XI–XII, figs. 15–18 incl.)

The two adult specimens that were collected are females 17.7 mm. and 26 mm. long respectively, each having a well developed marsupium which contains embryos in the smaller specimen.

The body is of elongate obovate outline, slightly assymetrical, widest at the third thoracic segment, behind which it tapers in width regularly to the end of the thorax. The head is but little set back into the thorax except that the first segment of the latter is extended forward in a small round-triangular lobe at each anterior corner. The sides of the head converge forward; the front is obtusely triangular, with a small rounded-triangular median point or process. The abdomen is of almost uniform width, not much less than that of the end of the thorax, and is but little set forward into the latter. The body surface is smooth and highly polished, of the usual yellow color without pigment except a very few blackish dots distributed chiefly along the median dorsal line and near the rear borders of the segments.

The upper surface of the head is convex and the anterior tip is considerably bent down. The eyes are small, rounded and situated on the sides of the head; they are well pigmented. The first antennae arise well apart. They are very short and stout, with eight joints, of which the second is considerably the longest, but not swollen. The joints are not compressed. The second antennae are slender and have but seven joints which are somewhat compressed. The first two are wide but very short, the others are so elongate that this pair of antennae slightly exceeds the first pair in length.

The first segment of the thorax is wide and moderately long; the second and third (the latter the widest of all, as above stated) are short; the succeeding ones are all rather long. They have rather narrow but thick epimera, which except in the case of the seventh, fail by a greater or less interval to reach all the way along the lateral end of the segment. The legs are only moderately

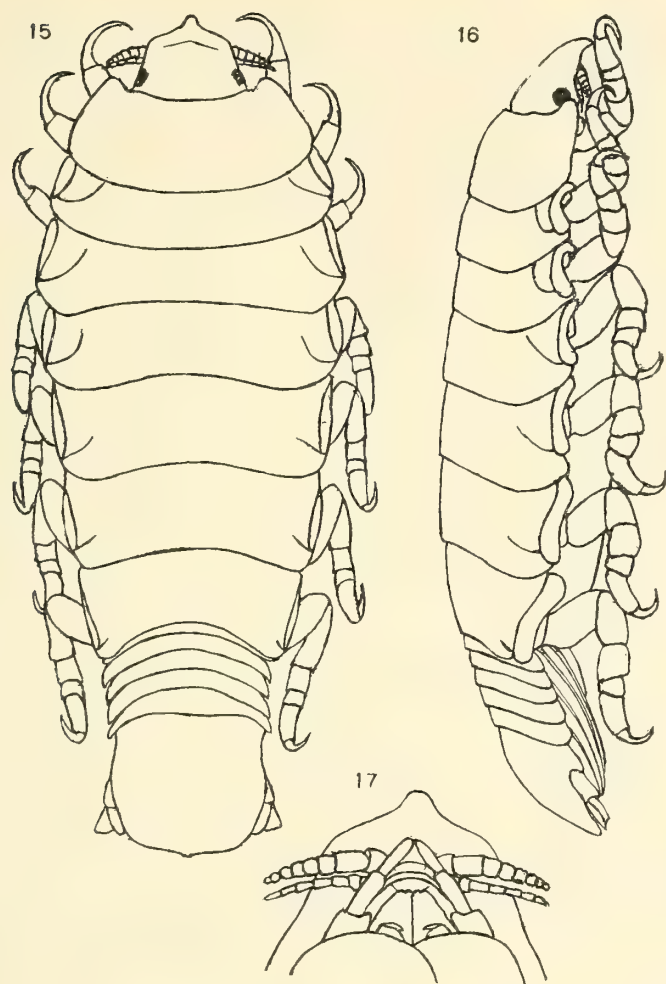


Plate XI.—*Livoneca guianensis*, sp. nov.; 15 and 16, female $\times 4.6$; 17, ventral aspect of head of same, \times about 10.

stout, but considerably compressed laterally, so that they appear much stouter in a side view. The dactyli are sharp and hooked, and vary comparatively little in length; those of the first pair are, however, the longest, although the last pair of legs exceeds the others in total length.

The abdominal segments have the lateral ends obliquely truncated and the posterior corners rounded off. The telson is about as wide as the rest of the abdomen and about as long as it is wide. It narrows but little toward the rear end, which is rounded off, but bent down so as to appear almost truncated in a dorsal view of the animal.

The uropoda are shorter than the telson. The outer branch is wide and somewhat obliquely truncated at the end; the inner branch is oval.

The smaller of the two (the type and subject of the figures) was collected by William Beebe at Kartabo, British Guiana, July 7, 1920.

The larger one (original number 201518) also from Kartabo, was taken from the gills of *Leporinus fasciatus* (Bloch). It differs little from the other except in size and in having the last thoracic segment somewhat shorter, the abdomen being more set back into it.

A third individual, only 12 mm. long and not over 3.9 mm. wide at the third

thoracic segment (thus proportionally narrower than the larger ones) is evidently immature. It was taken from the gills of a fish, *Pimelodus clarias* (Bloch), which had been eaten by a snakebird, June 3, 1924. (Collector's number 24818).

The collection contains also a small larval isopod (collector's number 2412) having the seventh thoracic legs still undeveloped, which was taken from the Giant Catfish (*Brachyplatystoma* sp.) March 4, 1924. I give a figure (fig. 18)

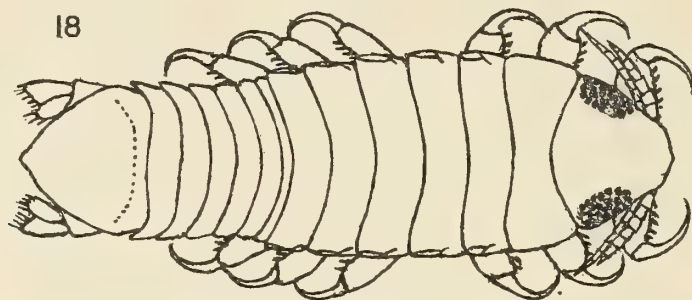


Plate XII.—18, Larval isopod, 2.4 mm. long; possibly young of *Livoneca guianensis*, sp. nov.

of this specimen here as possibly belonging to this species, but without committing myself to that opinion. Embryos taken from the marsupium of the type of the species just described (*Livoneca guianensis*), were in too early a stage to give evidence either for or against this view.

The specimen is only 2.4 mm. long and of decidedly flattened form. The anterior end of the head bends down slightly in front of the antennae. The eyes are large and have about 30 ocelli. The first antennae arise well apart; they are stout and do not much more than reach the rear border of the head. They apparently have 8 segments; the second pair are somewhat longer and slenderer and have 9 or 10 segments.

The six pairs of legs are rather long and all terminate in large curved dactyli which do not have their concave margins denticulated. The anterior edge of the propodus (the limb being laterally extended) bears a row of five or six short spines. This is true of all the legs. The propodus is moreover much widened and flattened, especially in the case of the first three pairs.

The abdomen is somewhat narrower than the thorax, but not abruptly so. The telson has an outline approaching an equilateral triangle with the lateral borders convex; its anterior margin is raised or thickened. The branches of the uropoda do not exceed the telson, their outer branches are truncated obliquely; the inner branches are smaller and of ovate outline. Both branches are fringed with a few short stout hairs.

Telotha henselii (von Martens), 1869.

Cymothoa henselii v. Martens, 1869, *Arch. Naturg.*, XXXV, part 1, p. 33, pl. II, fig. 6.

Telotha henselii Schioedte and Meinert, 1884, *Naturh. Tidsskr.* (3) XIV, p. 287, pl. X, figs. 11, 12; Richardson, 1904, *Proc. U. S. Nat. Mus.*, XXVII, p. 23; Niewstrasz, 1915, *Zool. Meded. Rijks. Mus. Leyden*, Ann. 1915, p. 95.

(Plate XIII, figs. 19–23 incl.)

The Kartabo collection contains nine specimens which appear to be refer-

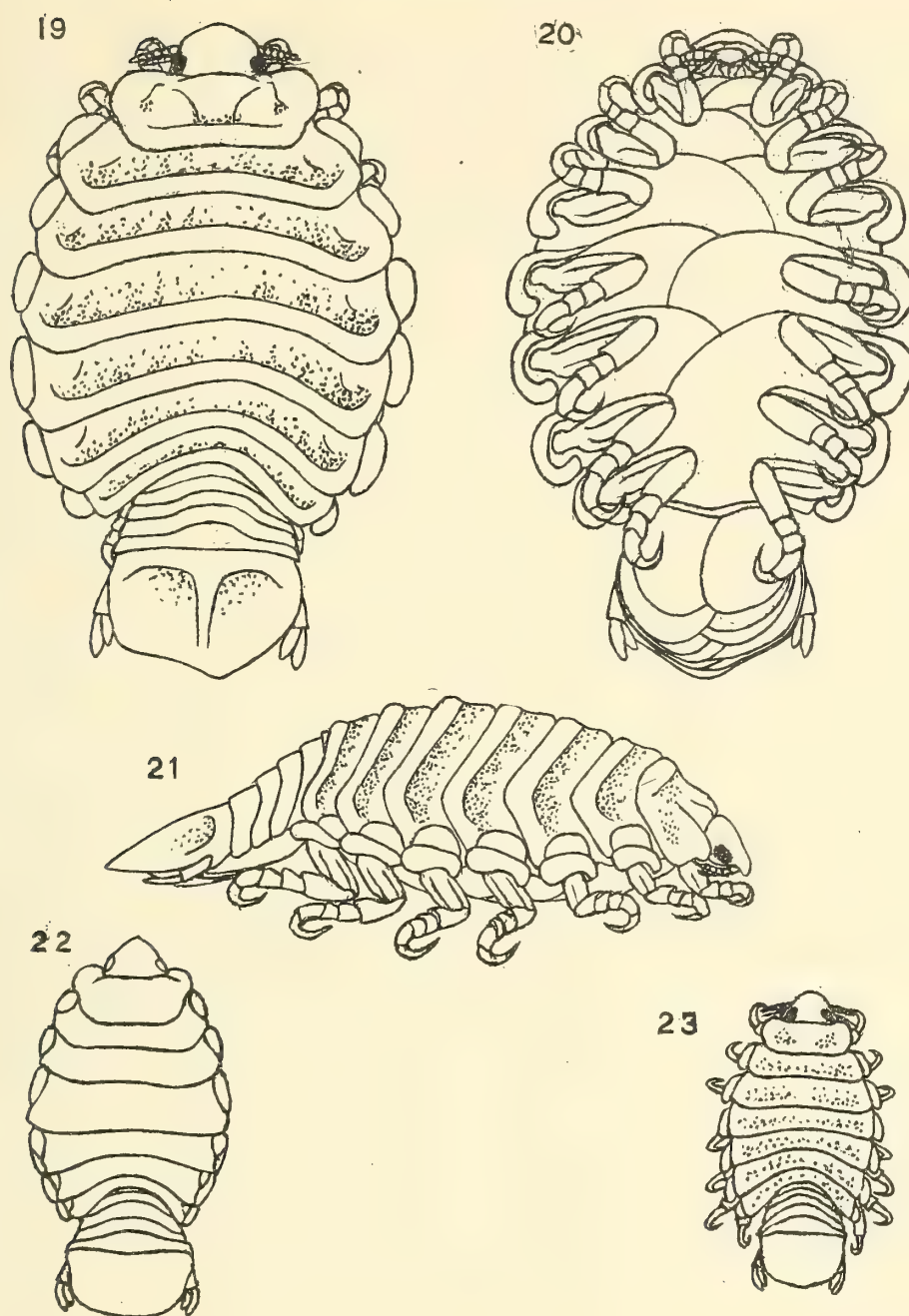


Plate XIII.—*Telotha henselii* (von Martens) 1869; 19 to 21, female (16 mm. long) 3.8; 22, very old individual (26 mm. long) $\times 1.4$; 23, young individual (6.6 mm. long) $\times 4$.

able to this species; they are of various ages ranging from a very large and old individual 26 mm. long down to immature ones little over 6 mm. long; these, however, have already reached a stage differing comparatively little from the adult (fig. 23). The largest individual has no marsupium but is apparently a female. If so, there is no adult male in the collection, neither have other authors given a description of it. The older specimens have the body surface practically devoid of any pigment (except in the eyes). Younger specimens have scattered, minute, blackish dots, chiefly near the lateral ends of the segments and along the anterior border of the telson, also a few along the median region of the back. The largest individual mentioned above, and shown in outline

in fig. 22, presents several small abnormalities, notably the exceptional length of the first and fourth thoracic segments (the second and third being unusually short), the tapering rather than oval outline of the anterior part of the body when seen in a dorsal view and the unusual length and more pointed outline of the anterior part of the head. The next largest individual, a female 16 mm. long by 10 mm. wide, having a well developed marsupium, has been chosen for the principal illustrations (figs. 19 to 21), as being a more typical specimen.

The body is quite broadly oval, rather highly arched in old specimens, but flatter in young ones. The head is wider than long and of triangular outline, rounded in front, its anterior margin is considerably bent downward. The eyes are oblong and fairly well pigmented; the first antennae, which arise a little distance apart, are stout, but little compressed in cross section, and have only eight segments (according to Schioedte and Meinert they have nine). The second antennae usually exceed the first pair a little in length, they are much slenderer and have nine segments. The head is not deeply set back into the thorax.

The thoracic segments have the posterior border thickened and very prominent, in front of this the surface of the segment is more or less irregularly roughened and sculptured. The epimera are large and thick, especially in the middle region of the body, and are surmounted by large convex bosses on the lateral ends of the main portion of the segments.

The legs are strong and of moderate length; their length increases toward the rear of the body. The dactyli are large and strongly hooked. The propodus of all the legs is curved, increasing the hook-like prehensile character of the limb; in the case of the three anterior legs that joint is somewhat flattened, though not much widened. The thighs are not compressed; their external aspect (the inferior aspect when the legs are drawn together under the body) is flattened or even slightly concaved. There is never more than a very slightly prominent ridge or keel.

The abdomen is rather narrow in front, moderately immersed in the thorax, and widens behind. The telson is very broad and has the posterior margin normally very gently curved, but in the individual shown in figs. 19 to 21, it is unevenly worn off, as are also some of the pleopoda, evidently by pressure and friction from some part of the host. The telson has the anterior margin thickened and the dorsal surface more or less arched or convex; in the older specimens there is a poorly defined median ridge or keel each side of which the surface is minutely pitted and roughened. The uropoda and their branches are small and short; in adults they do not reach much beyond the end of the telson.

Of the nine specimens from Kartabo, six, including all the larger ones, were together in a container bearing the collector's number 2412 and were taken from a giant catfish (*Brachyplatystoma* sp.), native name Lau-lau, March 4th, 1924.

Three small specimens have the collector's number 24757 and were taken from another catfish, *Pimelodus clarias* (Bloch), May 28, 1924.

The specimens of von Martens, five in number, were from the gills of a cichlid fish (*Geophagus* sp.) taken at Porto Alegre, Rio Grande del Sul, Brazil, and were also examined by Schioedte and Meinert. They are in the collection of the Berlin Museum. The latter authors mention also four other specimens from "somewhere in Brazil."

The differences in the outline of the individuals figured by von Martens and Schioedte and Meinert, as well as several small discrepancies between the figures of the latter and their descriptions, indicate that the specimens of these authors, just as in the case of those in the present collection, show considerable variations in many characters, and were I to regard the present specimens as constituting another species, it would be hard to find characters on which the distinction could be based. One of the most definite would seem to be their 8-jointed instead of 9-jointed first antennae, but I do not feel disposed to rely on this as a specific character, especially as some of the Kartabo specimens have their first antennae ending so bluntly that one might easily be led to assume that they had lost a segment at the tip.

The notes on the Kartabo specimens do not state on what part of the fish they were found, but from the nearly complete absence of pigment they seem most likely to have lived in the gill cavity as was the case with von Marten's examples.

Suborder EPICARIDEA

Family BOPYRIDAE

Probopyrus bithynis Richardson, 1904.

Probopyrus bithynis Richardson, 1904, *Proc. U. S. Nat. Mus.*, XXVII, p. 68, figs. 47-51; 1905, *Bull. No. 54, U. S. Nat. Mus.*, p. 557, figs. 606-611; Pearse, 1911, *Rep. Michigan Acad. Sci.*, XIII, pp. 108, 109; 1915, *Proc. U. S. Nat. Mus.*, XLIX, p. 550.

(Plates XIV-XV, figs. 24-26 incl.)

A considerable series of specimens from Kartabo shows that this species is a common parasite of the shrimp *Macrobrachium lamarrei* (Milne-Edwards), 1837. It has been previously recorded by Richardson (1904, 1905) from New

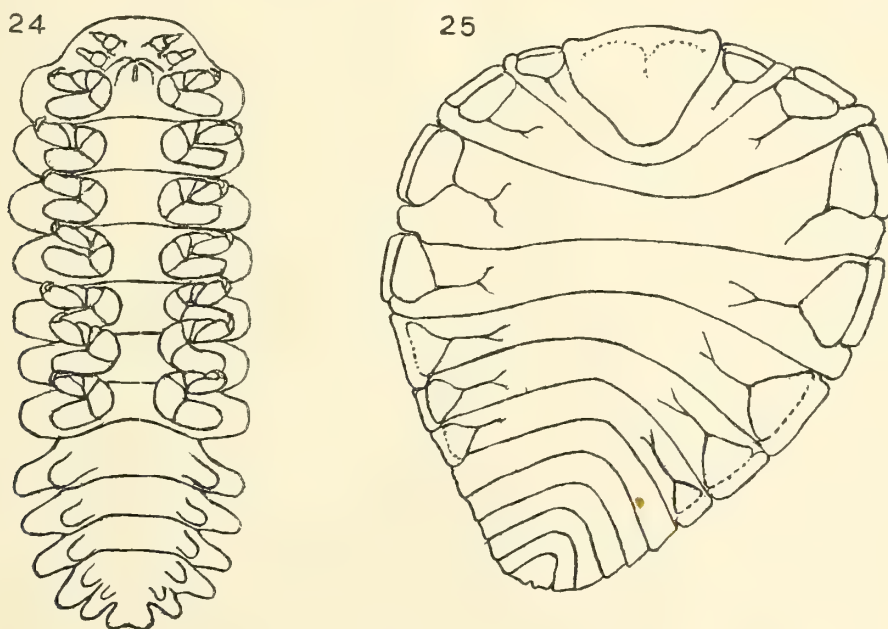


Plate XIV.—*Probopyrus bithynis* Richardson, 1904; 24, male, ventral aspect, $\times 28$; 25, female, dorsal aspect. $\times 5$.

Orleans, Louisiana, on *M. ohionis* (Smith), and Bluefields, Nicaragua, on *M. acanthurum* (Wiegmann); by Pearse (1911, 1915) from the State of Vera Cruz, Mexico and from Santa Marta, Colombia, on *M. olfersii*, and has been so well described and figured by Richardson that its characters need not be considered in much detail here. The present specimens infest shrimps of from nearly 50 to somewhat over 80 mm. in length (inclusive of the rostrum). No infested examples were among the other specimens of this shrimp of lesser or greater length that were collected, indicating that there is a particular and somewhat limited age or size favorable for becoming parasitized. Except in one case the parasites are all adult; in almost all cases they have the marsupium well distended with eggs, and usually one of the minute males may be found clinging to the ventral side of the abdomen of the female, between and partly covered by the pleopoda. The single exception is a small very poorly preserved and evidently immature parasite in the smallest of the infested shrimps, an individual a little under 50 mm. long.

The female parasite lies in the branchial chamber of the shrimp, with the head directed posteriorly and usually somewhat dorsally (relative to the host's

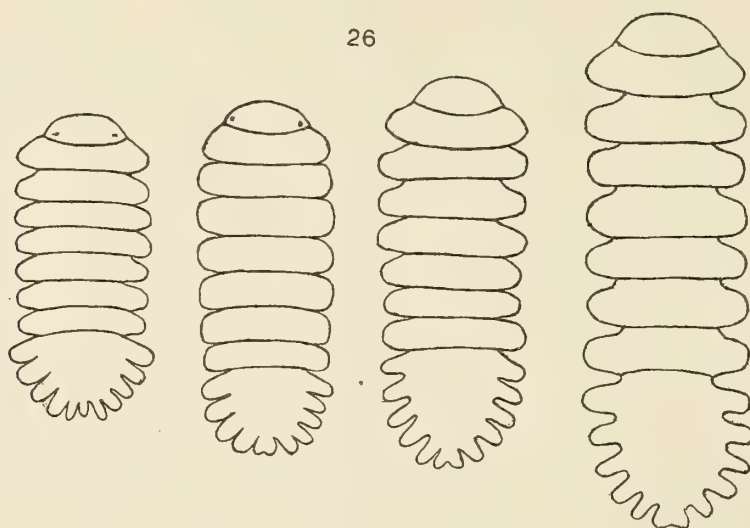


Plate XV.—26, *Probopyrus bithynis* Richardson, 1904. Outlines of segments of four male individuals to show variation in size and form. $\times 16$.

body) and with the ventral aspect outward and the dorsal aspect, which is perfectly flat, against the gills of the host. The body of the female is asymmetrical to a varying but usually considerable degree; the convexity of the long axis is toward the ventral side of the host, and consequently toward the left if the parasite was borne in the left branchial chamber of the host and toward the right in the opposite case. No shrimps were found infested on both sides. The female is without eyes, and measures in greatest length 10 to 11 mm. in the case of the largest individuals, which are naturally to be found in the larger and presumably older shrimps. The marsupial plates, which are far too short to completely cover the immense mass of eggs that the animal bears, are more or less pigmented with conspicuous areas of blackish pigment, some of which also occurs on the lateral parts of the segments of the shorter side of the body

on both ventral and dorsal sides of the thorax on the dorsal side, especially along the lines of articulation between these segments. The amount and intensity of the pigment is variable; it is usually quite conspicuous, even through the carapace of the host, which of course exhibits a large localized swelling over the location of the parasite. The head may or may not have the anterior lateral corners produced into more or less distinct lobes. Each of the pleopoda consists of a short basal portion bearing two broad leaf-like smooth-edged branches. There are five pairs, decreasing in size from the first to the fifth segment of the abdomen. Uropoda are wanting.

The males vary in length from 1.7 mm. to about 3 mm., this difference being due in part to actual individual variation, but still more largely to the state of contraction of the body muscles, the body being very soft. This is clearly shown in the outlines of four individuals shown in Fig. 26, which also brings out the fact that the degree of constriction between segments is largely a matter of the degree of contraction and cannot be relied on as a specific character.

The body of the male is of oblong outline, moderately arched, with the thoracic segments all distinct and the abdominal segments all fused into a somewhat semicircular flattened mass with eleven rounded lobes around the margin. Ten of these represent the lateral ends of the abdominal segments; the median one, which may be longer or shorter than the adjacent lobes and is usually more or less emarginate or partially cleft into two, represents the telson. The head is rather short and wide and bears two minute pigment spots (sometimes not discernible) representing eyes. The mouth parts form a projecting mass on the lower side of the head, the two pairs of antennae are short and composed of a short, swollen basal part and a slightly longer abruptly narrower portion, on the extreme tip of which there are, on the first pair only, one or two very minute articles, but owing to the soft character of the structures and the indistinctness of the articulations the number of joints was not satisfactorily determined. The thoracic legs are all well developed and bear small but sharp and strongly hooked dactyli; the pleopoda are represented by five pairs of small rounded lobes or projections. No uropoda are present.

Twenty-nine parasitized shrimps of the above species were collected, each bearing a female to which a male is usually attached. (Original numbers 20903, 201532 and 201556, the last is dated 3-9-1919).

P. floridensis Richardson, 1904, p. 70, figs. 52-55; 1905, p. 555, figs. 602-605, from the St. John's River, and Miami, Florida, parasitic on *Palaemonetes exilipes*, is an allied species though apparently distinguishable by the somewhat rounded ends of the abdominal segments in the female, those of *P. bithynis* being squarely cut off. Another evidently closely related form is *P. pandalicola* (Packard), 1879 (see Richardson, 1905, p. 554, figs. 599-601) recorded from various points on the American coast from New Hampshire to Florida and Mississippi, parasitic on *Palaemonetes vulgaris* (Say) or allied species. This appears to be distinguished from *P. bithynis* chiefly by having the posterior prolongations of the first pair of marsupial plates distinctly hooked, and the lobes representing the fifth abdominal segment fused with the median one representing the telson.

P. panamensis Richardson, 1912 (Proc. U. S. Nat. Mus., XLII, p. 523, figs. 5-8) from the Canal Zone, Panama, parasitic in *Macrobrachium acanthurum*,

is still another closely allied form, distinguished by having the telson of the female notched (which, however, is often the case in the present species), and by having only the two last abdominal segments of the male fused into a distinctly separated piece.

Suborder ONISCOIDEA

Family ONISCIDAE

Subfamily EUBELINAE

Ethelum americanum (Dollfus), 1896.

Mesarmadillo americanus Dollfus, 1896, *Proc. Zool. Soc. London*, ann. 1896, pp. 397-398, Richardson, 1901, *Proc. U. S. Nat. Mus.*, XXIII, p. 573.

Ethelum americanum Budde-Lund, 1899, *Rev. Crust. Isopod. Terrest.*, p. 24; 1899, *Entomol. Meddel.*, (2) I, Pt. 2, p. 90; Richardson, 1905, *Bull.* 54, *U. S. Nat. Mus.* p. 589, figs. 649, 650 (copied from Budde-Lund and Dollfus respectively); Pearse, 1917, *Occ. Papers Mus. Zool. Univ. Michigan*, No. 46, p. 1.

(Plate XVI, figs. 27-36 incl.)

I have little hesitation in referring the three small specimens listed below to the present species in spite of two or three discrepancies.

The largest female would measure, if straightened out, a trifle over 6 mm. long, the only male specimen scarcely 5 mm. long. The color is grayish brown above, with small light yellowish markings, the uropoda reddish yellow, and the legs and under parts yellowish.

The description given by Dollfus and quoted in Richardson (1905) is excellent for a brief diagnosis, but its shortness makes the mention of some other details desirable. The body is convex, and not very wide, with nearly vertical epimera except on the abdomen, where they bend or flare outward a little. Surface smooth except for a slight individual convexity of each segment, and a slight, scabrous pubescence; pubescence is more pronounced on the antennae and limbs. As shown in Dollfus' figure the epistome is continuous with the forehead in the middle, but ends in a small rounded slightly projecting lobe under each eye, separated from the forehead by an impressed line or groove. A branch of this groove (not shown in Dollfus' figure) runs up on the forehead a little way, along the inner side of the eye. Ocelli about 13 in the smaller specimens, the largest female has a few more.

The first thoracic segment has a slightly projecting lateral border which is wide (especially toward the front) in a lateral view and is separated from the body of the segment by a very deep furrow that curves sharply upward as the head is approached. It does not reach all the way to the posterior end of the segment. The posterior corner has a short V-shaped cleft to receive the second segment when the body rolls up. This cleft has the outer side (forming the posterior lateral angle of the segment) obliquely truncated; the inner side, which is very slightly longer, is sharply rounded off. The lateral ends of all the thoracic segments are somewhat rounded, the second, third and fourth more than those behind them. All the thoracic segments have the rear corners produced backward a little, but to a less extent as the posterior end is approached.

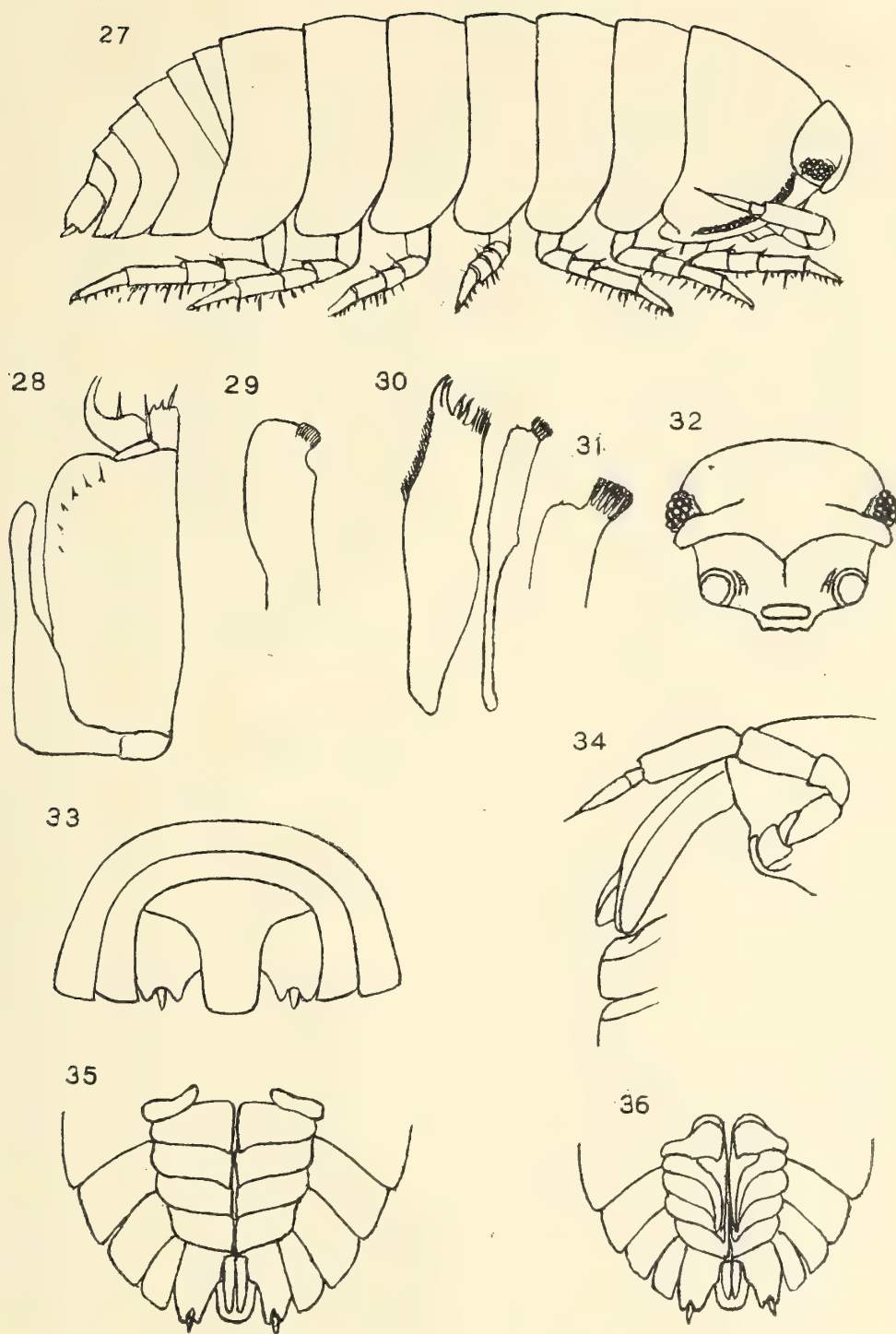


Plate XVI.—*Ethelum americanum* (Dollfus) 1896; 27, female $\times 13$; 28, maxilliped $\times 52$; 29, second maxilla $\times 52$; 30, outer and inner divisions of first maxilla $\times 52$; 31, tip of inner division of first maxilla $\times 52$; 32, front of head $\times 16$; 33, rear end of body $\times 18$; 34, ventral aspect of anterior segments and antenna $\times 18$; 35, ventral aspect of rear end of body of female $\times 13$; 36, same of male $\times 11.5$.

The legs are slender but fairly long, with only moderately developed spines. The basal segments of the uropoda are thick and convex, standing out more than the telson. The external branches are small and of tapering form, and are inserted in a deep notch in the extreme end of the basal segments.

The chief discrepancies between the above described specimens and previous descriptions are that I find no coxopodite process on the second thoracic segment, which merely has the anterior edge of the epimeral part thickened as though by an infolding of the edge (the third segment also shows this to a less degree); that the inner branch of the first maxilla bears five instead of four plumose tufts (verified on both right and left sides); and that the inner branches of the uropoda are longer than described, reaching nearly or quite to the end of the telson. I do not feel justified in assuming that the present specimens are a new species because of differences so small and so likely to be explainable by the difficulties of exact observation in the case of such a small form.

These specimens were collected by William Beebe at Kartabo under dead wood at the edge of the jungle, September 22, 1922. (Collector's number 221115). It has also been recorded from Dunoon, British Guiana, on trees among bromeliads, vines, etc., by Pearse, 1917. The species was described by Dollfus from St. Vincent, W. I.

Subfamily ONISCINAE

Leptotrichus pittieri Pearse, 1921.

Leptotrichus pittieri Pearse, 1921, *Proc. U. S. Nat. Mus.*, LIX, p. 460, fig. 1

(Plate XVII, figs. 37-42 incl.)

I feel little hesitation in referring the specimens here illustrated to this species, which was briefly described by Pearse, in spite of two small discrepancies that his figures show, the antero-lateral lobes of the head being somewhat more prominent and angular and the telson a little narrower in his figures than I find them to be in the Kartabo examples.

The body is rather broad and, as seen from above, of ovate outline, the head wide and short and set back nearly half its length into the thorax, and the abdomen rather small and tapering. It is of rather delicate structure, the segments and limbs being loosely articulated and the length to width ratio of the body varies very greatly with the degree of contraction of the muscles connecting the segments. The specimens in the collection range from about 3 mm. to 4.2 mm. long, the variation being due more to different conditions of contraction than to size. The specimen illustrated in figs. 37 and 38 has them considerably contracted and the segments drawn well together. It is possible that the females are somewhat wider-bodied than the males, but this is difficult to determine certainly in the varied states of contraction of the preserved specimens. The color is light yellowish or yellowish white, the body being unpigmented.

The most characteristic feature of the species is the one first mentioned in Pearse's short description and illustrated in one of his figures. This is the modification of the hairs or setae covering the body into minute, short, thick, often

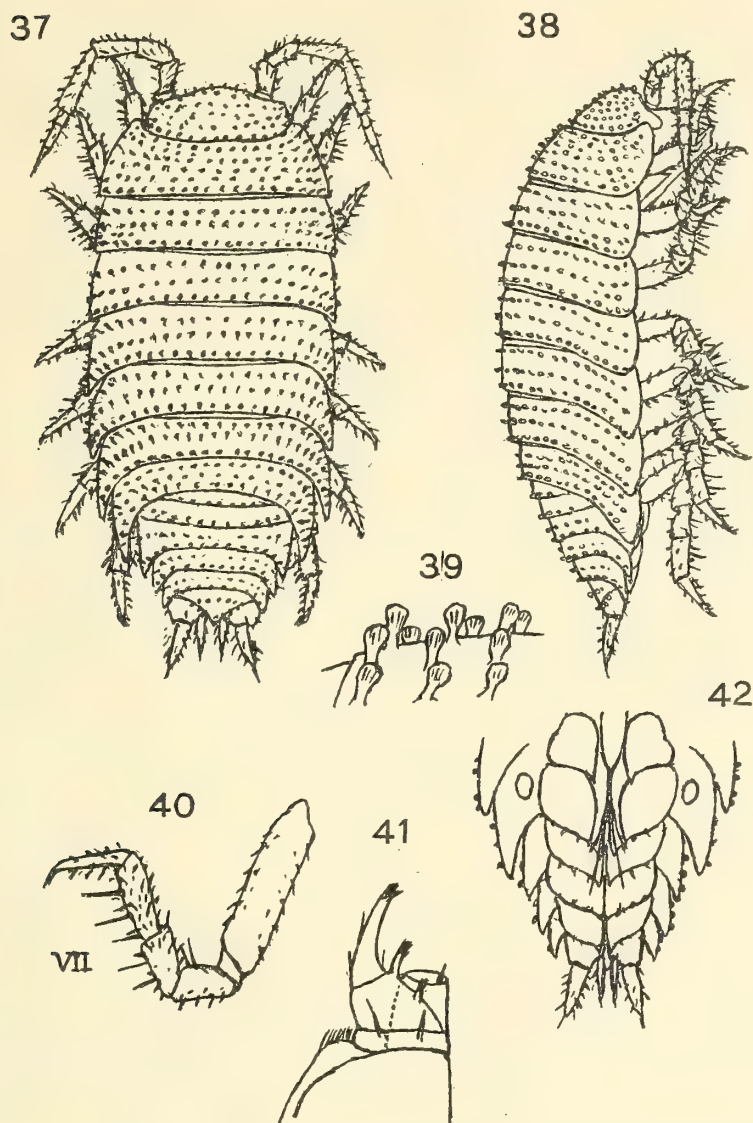


Plate XVII.—*Leptotrichus pittieri* Pearse, 1921; 37 and 38, female $\times 16$; 39, modified setae on dorsal surface $\times 60$; 40, seventh leg $\times 32$; 41, tip, of maxilliped $\times 94$; 42, lower side of abdomen of male, $\times 21$.

distinctly club-shaped or capitate processes of a soft, flexible consistency (fig. 39). On the antennae, legs, pleopoda, etc., however, the setae retain their original hair-like character and intermediate conditions between ordinary hairs and the club-shaped structures may be observed on various parts of the body.

On the back these modified setae are arranged in fairly regular transverse rows, some thirty or more in a row in the wide parts of the body, and three rows on most of the thoracic segments, though there are four on the lateral parts of the second segment and more numerous rows on the first segment and head. The abdomen has one row on the first and second, two on the third, fourth and fifth segments. When these structures are rubbed off, which easily happens, the body is left quite smooth. The antennae are rather short and have the flagellum with two distinct articles, the first one rather short. The second article exhibits, however, a more or less noticeable joint a little beyond its middle, but this is apparently so firmly consolidated as to be immovable. Apparently we have in this species a form in which the flagellum, originally

composed of three articles, is becoming reduced to a two-segmented condition by the fusion of the two terminal articles. The eyes are very poorly developed and inconspicuous.

The first thoracic segment is the longest, the seventh the shortest. All except the first have the posterior angle extended back to a successively increasing extent. This angle is well rounded off in the first four thoracic segments, and not actually sharp in any of them. The third to fifth abdominal segments have the corresponding angles sharp and also well extended back. The legs are of moderate length, stout and well provided with spines and hairs. Sexual differences in them were not noted.

The telson is triangular, with slightly concave sides; the external branches of the uropoda are stout at the base, tapering rapidly to a point, and are of more or less terete section. The inner branches are somewhat shorter, as well as being inserted on the basal joint at a point farther forward, and are compressed so as to appear narrow in a dorsal but rather wide in a lateral view.

Three specimens were obtained at Kartabo from dead wood (Collector's number 22349). Another was obtained by sifting, and still another is without data. Their unpigmented body and rudimentary eyes show adaptation to a burrowing life.

Pearse described the species from a specimen found under a log at Maracay, Lake Valencia, Venezuela. He does not indicate that he had more than one specimen.

Circoniscus gaigei Pearse, 1917.

Circoniscus gaigei Pearse, 1917, *Occ. Papers Zool. Mus. Univ. Michigan*, No. 46, p. 4, fig. 2.

(Plate XVIII, figs. 43-51 incl.)

The largest specimen of this species in the Kartabo collection is a male which, if it could be straightened out might measure nearly 16 mm. long; the largest female would probably measure about 13 mm. The ground color of the upper parts of the alcoholic specimens varies from rather dark grayish brown to pale brown with a grayish tinge. There are numerous very small somewhat irregular yellowish markings on the forehead and lateral parts of the back; the lower parts, limbs and antennae are unpigmented and of a uniform yellow color. Two of the females have marsupial plates but are not carrying young. The plates are rather small and do not overlap much along the median line.

Body highly arched, and fairly broad in spite of the lateral ends of the segments extending down almost vertically. An exception to this statement is that the first thoracic has the front part of the border narrowly rolled outward and that the ends of the third, fourth and fifth abdominal segments bend or flare outward a little. Articulation firm and compact. In a dorsal view the front of the body (including the front of the head) is rounded in a broader curve than the posterior end.

Body surface very smooth and even. No tuberculation. The surface is very thickly dotted with minute, scabrous punctae bearing very minute short hairs. On the antennae, legs, etc., there is a coarser and more conspicuous pubescence. Legs rather weak and slender, with rather weak but moderately numerous spines.

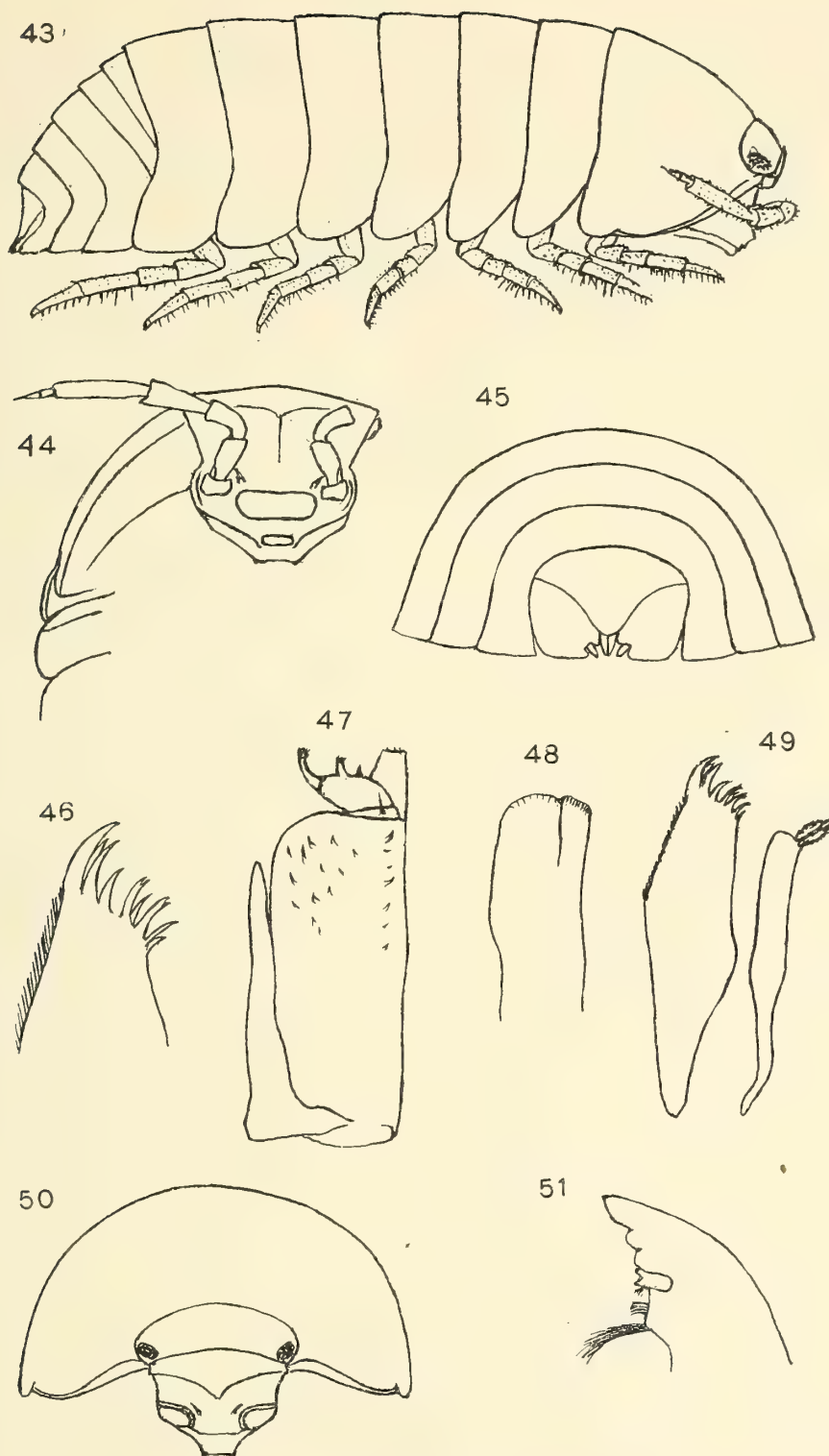


Plate XVIII.—*Circoniscus gaigei* Pearse, 1917; 43, female $\times 6.5$; 44, ventral aspect of anterior segments $\times 8$; 45, rear end of body $\times 8$; 46, tip, of outer division of first maxilla $\times 40$; 47, maxilliped $\times 28$; 48, second maxilla $\times 28$; 49, inner and outer divisions of first maxilla $\times 28$; 50, front of head and first thoracic segment $\times 6$; 51, tip of right mandible $\times 35$.

Head rather narrow, forehead low, upper edge of the epistome arched, forming a projecting upturned border distinct all the way across the head. First antennae minute, composed of three segments, the second the shortest; the terminal one much more slender than the others. Second antennae short and small, conspicuously and stiffly pubescent, the flagellum of two very small short articles which together are less than one-third the length of the last segment of the peduncle and of much smaller diameter than the latter. The terminal article bears a rather large, movable terminal bristle. The mouth parts form a very prominently projecting mass. Mandible with a row of four small tufts of hairs ("penicilli") on the inner aspect distal to the large brush-like tuft. Eyes rather small, ocelli fairly numerous, apparently at least twenty-five in the largest specimens but not all well defined or well pigmented.

First segment of the thorax rather large and wide, the anterior part of its lateral border narrowly rolled outward to form a rather thin projecting border. This diminishes toward the rear and disappears a little way from the rear corner where the rear part of the lateral face of the segment extends down vertically into a small semicircular lobe that forms the posterior lateral corner of the segment. In a ventral view it can be seen that this lobe forms the outer and longer side of a very small V-shaped notch for the reception of the second segment when the body is tightly rolled up. The inner side of the notch is very short and much thicker. The border of the segment is not sulcated. The inner side of the lateral part of the second segment has the anterior edge thickened, but no process is developed on this or on any succeeding segment. Lateral ends of second, third and fourth thoracic segments narrow and sharply rounded; the fifth is rounded on a larger curve, and the sixth and seventh more squarely cut off.

The abdominal segments, including the large basal segments of the uropoda, are squarely truncated. Telson triangular, with curved sides and a slightly rounded apex which does not quite reach the end of the body, the tips of the two inner branches extending a little beyond its apex. The outer branches are very small and short and inserted in notches in the extreme inner posterior corners of the basal segments, thus coming close against the terminal parts of the inner branches.

Three of the specimens from Kartabo are without collector's notes, the other two were found as follows:

Collector's number 22349 from dead wood July 5, 1922.

" " 22448 from a dead stump July 23, 1922.

Pearse (1917) described this species from specimens from Dunoon, British Guiana, where it was collected in rotten logs, under loose bark of trees, and also in dry sand. He established for it the new genus *Circoniscus*, resembling the Old World genus *Synarmadillo* Dollfus, in many characters. One of its distinctions from *Synarmadillo* is in its possessing a row of four small tufts of hairs ("penicilli" in the terminology of Budde-Lund) on the inner aspect of each mandible distal to the large brushlike tuft, instead of only a single one, a character that Budde-Lund considered of considerable weight in the classification of this subfamily. As noted by Pearse, the new genus appears to be related to *Sphaeroniscus* Gerstaëcker, 1881, and to *Spherarmadillo* Richardson, 1907,

from Guatemala (see Proc. U. S. Nat. Mus., XXXII, p. 447), but these have the second antenna with a flagellum of three articles. *Haplarmadillo* Dollfus, from St. Vincent, W. I., (Proc. Zool. Soc. London, ann. 1896, p. 400), is apparently also allied; this, however, has the flagellum of the second antenna, though rather long, composed of but one article. *Paracubaris* Collinge, 1918, also established for a British Guiana species, *P. spinosus*, does not appear sufficiently distinct, and his species should probably be placed in *Circoniscus* with the present one.

Philoscia nitida (Miers), 1877.

Philougria nitida Miers, 1877, Proc. Zool. Soc. London, ann. 1877, p. 670, pl. LXIX, fig. 3.

Philoscia nitida Budde-Lund, 1885, Crust. Isop. Terr., p. 222; 1893, Entom. Meddel., ann. 1893, p. 122 (mentioned for comparison); 1906, Voeltzkow, Reise in Ostafrika, II, p. 289; Pearse, 1915, Proc. U. S. Nat. Mus., XLIX, pp. 532, 534, 542.

(Plates XIX-XX, figs. 52-59 incl.)

General outline of body elliptical, in a dorsal view rather wide (width often exceeding .4 of the length of body and head); the back well arched; the head and abdomen very small. Body surface very smooth and shining, though bearing a few scattered setose hairs. These are more numerous on the antennae, pleopoda, and a few other parts. Lateral ends of thoracic segments with a very narrow slightly thickened border, but this is not conspicuous.

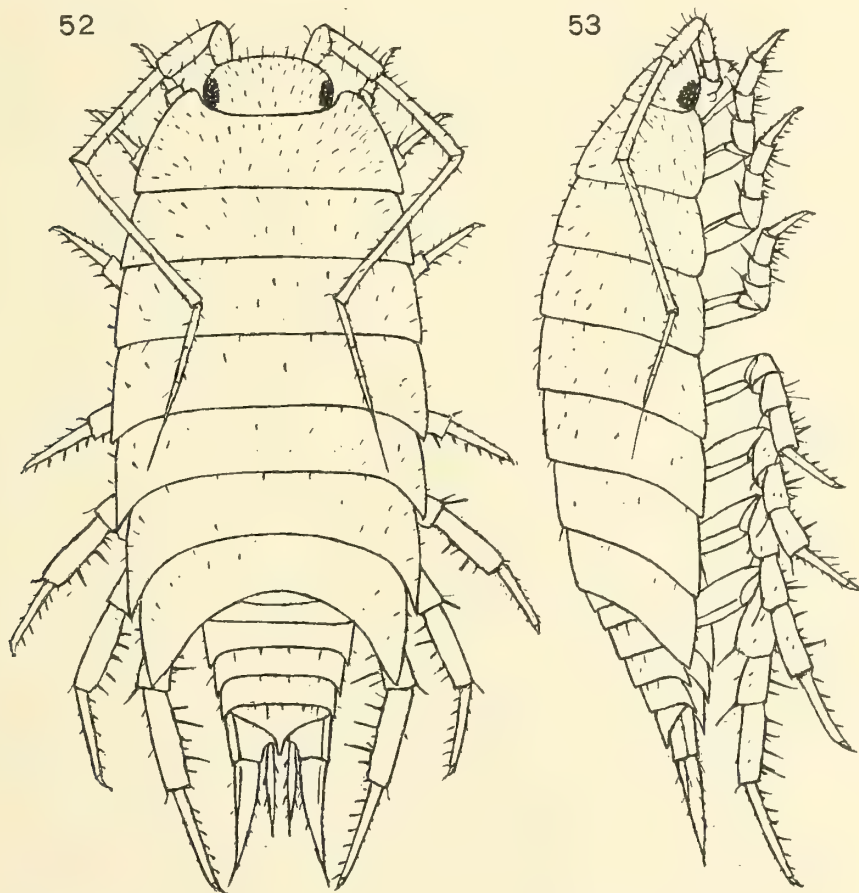


Plate XIX.—52-53, *Philoscia nitida* (Miers), 1877. Female $\times 7$.

Coloration rather conspicuous; in addition to the usual irregular light markings on the dorso-lateral regions and on the head, the purplish brown ground color of the back is variegated by a darker stripe on each side in the region of the bases of the thoracic epimera; in this stripe there is on each segment a large, conspicuous, more or less irregularly oblong light (unpigmented) spot; there is also a median series of light spots which in some individuals lie in a darker median stripe. On the thoracic epimera the purplish pigment fades out so that the thorax seems to be bordered by a broad, somewhat lighter stripe outside the dark lateral stripe in which the large spots lie. Abdomen and telson mostly purplish brown, though median lighter spots are present and the projecting angles of the segments are not pigmented. The external branches of the uropoda are dark but crossed by a broad light band at the middle. The largest specimens from Kartabo do not much exceed 9 mm. in length, but the collections of the American Museum contain females up to 11.5 mm. and males up to 11.2 mm. in length from other British Guiana localities.

Head small and narrow, not very deeply set back into the thorax. Seen from above, its front outline is smoothly convex without a suggestion of lobes. Seen from one side or in front, the forehead slopes down to form a prominent though somewhat rounded-off horizontal border extending across between the eyes, below which the head is abruptly much contracted. The mouth parts form a downwardly and somewhat forwardly projecting mass of smaller proportionate size than in many other members of the genus. Eyes obliquely oval with 16 to 19 ocelli.

Second antennae of considerable length but quite slender, especially the last joint of the peduncle and the flagellum, which bears a long terminal bristle. Their length is subject to much individual variation. When strongly drawn back, the tip of the terminal bristle can reach nearly or quite to the abdomen in some individuals, in others hardly more than to the fifth segment of the thorax. The first of the three articles of the flagellum somewhat exceeds in length either of the other two, that nearly equal each other. This is exclusive of the terminal bristle which may itself exceed half the flagellum in length. The latter is but about two-thirds or less of the length of the last joint of the peduncle.

The thoracic segments all have the posterior lateral angles extended backward and in an increasing degree from only very slightly in the first to very greatly in the sixth; in the seventh a little less than in the sixth. These angles are a little rounded off in segments I and II, but usually not so much in segment III; the extreme tip is either acute or very slightly rounded in IV; the posterior segments have the angles acute. The legs have only moderately well developed spines. The three anterior pairs of legs are rather short and weak, legs IV to VI are successively longer, while the seventh pair are considerably longer and stouter than any of the others, so that we may credit the animal with probably having some power of jumping. The claws of the dactyli are small, especially in the posterior legs. The legs are similar in the two sexes. The abdominal segments 3 to 5 have the posterior lateral angles extended into narrow, sharp points directed straight backward. The telson is wider than long, of somewhat triangular outline with the sides very slightly sinuously or concavely curved and a not very sharp though slightly acuminate tip. The basal joints of the uropoda are rather long, exceeding the tip of the telson, and are conspic-

uously furrowed on their external aspect. Their external branch is quite long and sharply tapering or subulate, little flattened, though slightly furrowed on the external aspect. The inner branches are quite slender, somewhat compressed from side to side and scarcely reach half way along the outer ones. They are inserted considerably forward of the end of the basal joint.

The collection contains five specimens. The one figured (a female) and a male specimen bear the collector's number 201146 and were found in dead wood. Another female (collector's number 24833) was found under the bark of a dead tree, while a male and a female are without collector's notes.

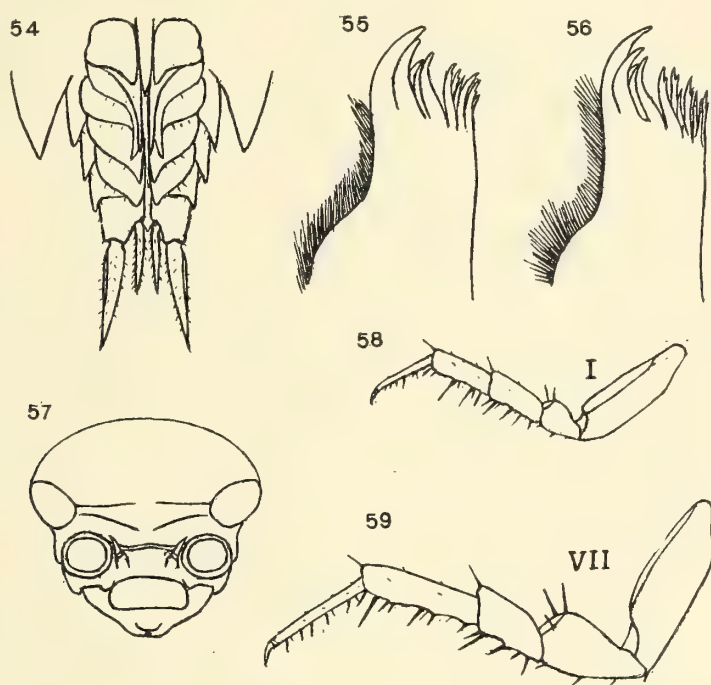


Plate XX.—*Philoscia nitida* (Miers), 1877; 54, ventral aspect of abdomen of male $\times 5$; 55 and 56, tip of outer division of first maxilla of two individuals $\times 75$ and 62 respectively; 57, front of head $\times 12$; 58 and 59, first and seventh legs $\times 10$.

I refer these specimens to Miers' *P. nitida* with much hesitation, their correspondence with the insufficient descriptions and figures that have been published, being none too satisfactory. The types or at least original specimens of Miers were examined in the Warsaw Musum by Budde-Lund and are presumably still to be seen there, so that the latter author cannot have made any mistake in identification. They came from "Peru and Guiana," according to Miers. He says "the specimens from Guiana generally appear rather more coarsely granulated," while Budde-Lund says of the species, "nitidissima, glabra, vix vel minutissime et sparsissime punctata." The Kartabo specimens would be better described as extremely smooth; only under high magnification does the surface exhibit a very minute, even granulation suggesting very fine sandpaper, and too fine to interfere with the glossy appearance of the animal when seen without much magnification or with none at all. Budde-Lund (1906, p. 289) makes *P. nitida* the type of a subgenus *Hesca* which he does not define, but which he says shows affinity to *Sphaeroniscus*.

Pearse, 1915, who gives no description or figure, records *Philoscia nitida* as an abundant species in the Santa Marta, Colombia region from La Rosa (altitude low) to the top of Mt. San Lorenzo (8500 feet), and sometimes occurring in the water of the mountain streams as well as in damp places on land in the forest. If he is really dealing with the same species as Miers and Budde-Lund, *P. nitida* must be widely distributed in South America, increasing the probability that I am correct in referring the Kartabo specimens to it. I may add that the American Museum of Natural History has specimens identical with those from Kartabo from various other British Guiana localities.

Philoscia maculata Budde-Lund, 1885.

Philoscia maculata Budde-Lund, 1879, *Prosp. Crust. Isop. Terr.*, p. 2 (nomen nudum); 1885, *Crust. Isop. Terr.*, p. 215 (description); Kraepelin, 1901, *Mitt. Naturh. Mus. Hamburg*, XVIII, p. 204; Budde-Lund, 1906, *Voeltzkow, Reise in Ostafrika*, II, p. 287.

(Plates XXI–XXII, figs. 60–63 incl.)

Three specimens in the collection from Kartabo, all females, the largest of them little over 5 mm. long, represent a species evidently very close to this form described by Budde-Lund, though his description, which is unaccompanied by any figure, is insufficient to allow of my assigning these specimens to it except provisionally; since reexamination of that author's material might disclose differences precluding such identification.

The collection of the American Museum contains other specimens of both sexes apparently identical with those from Kartabo from other British Guiana localities. Some of these measure between 6 and 7 mm. long.

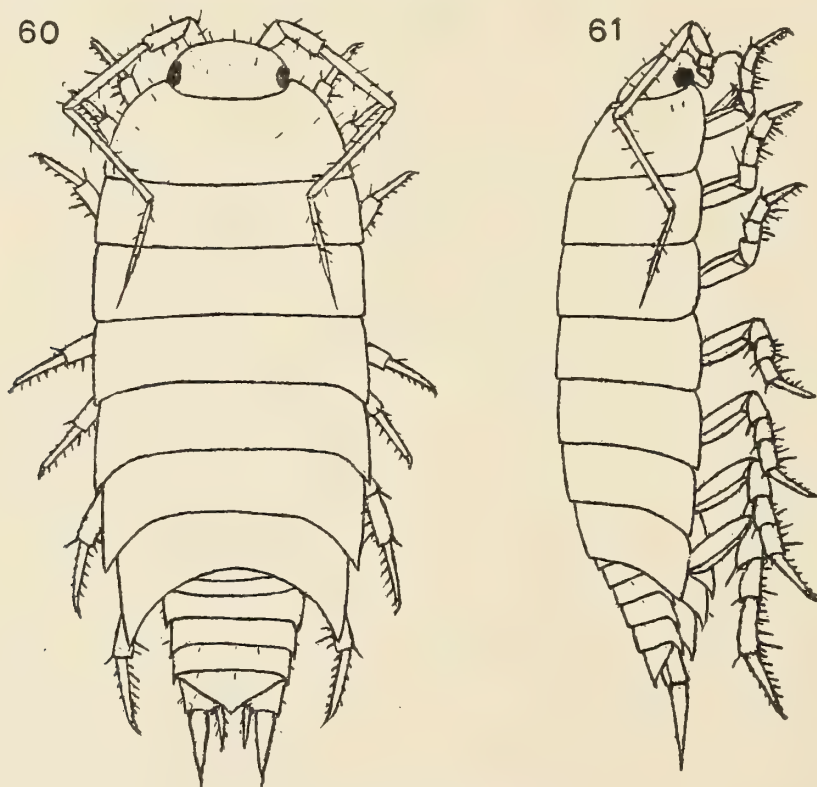


Plate XXI.—60–61, *Philoscia maculata* Budde-Lund, 1885. Female $\times 12$.

In a dorsal view the body is of oblong-elliptical outline and broadly rounded in front, the head being small and narrow, and considerably set back into the thorax, and the abdomen rather small and short. Body surface very smooth and for the most part free from any setose hairs, though a few are present on the head, antennae, uropoda, etc. Color purplish brown above, with numerous small irregular light (unpigmented) bars and spots on the dorso-lateral regions and head as usual in the genus, but in addition there is a row of large, somewhat square, light spots on the lateral part of the thorax on each side, at the junction of the epimeral with the main part of the segment. Very obscurely indicated darker median and lateral longitudinal stripes are sometimes discernible. The under parts are mostly unpigmented, though there is some of the purplish brown pigment on the maxillipeds, thighs, pleopoda and some other parts.

When seen directly from above, the front outline of the head appears convex and smoothly curved with no indications of lateral lobes. In a more or less anterior view it appears somewhat sinuous. The eyes are rather large and unusually round; they are well pigmented and have a dozen or more ocelli well developed. Antennae of moderate length, usually reaching, when strongly drawn back, the fifth thoracic segment. Flagellum (exclusive of its terminal bristle) considerably shorter than the fifth segment of the peduncle; the first of its three articles very slightly exceeds either of the other two, which do not differ greatly in length.

The first three thoracic segments have the posterior lateral angles rounded and not at all extended backward. The fourth has the angle nearly sharp, in

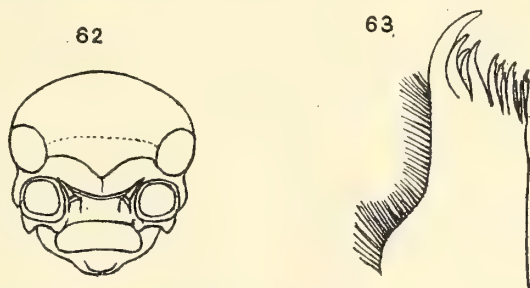


Plate XXII.—*Philoscia maculata* Budde-Lund, 1885; 62, front of head $\times 18$; 63, tip of outer division of first maxilliped $\times 100$.

the remaining three it is actually so. Beginning (very slightly) with the fourth, the remaining thoracic segments have the posterior lateral angles extended back to an increasing extent. Legs only moderately long, increasing considerably in length toward the rear of the body. No sexual differences in the legs were discovered.

Abdomen rather small and tapering. The third, fourth and fifth segments have the posterior lateral angles extended back into small appressed triangular points. Telson broadly triangular with a fairly sharp apex and nearly straight (in some individuals somewhat sinuously curved) sides. Basal joints of uropoda and outer branches of same with a furrow on the external aspect; the basal joints extend about as far as the tip of the telson. Outer branches are short and taper rapidly, and are tipped by a short bristle, which, however, is not always present. The inner branches are small and compressed from side to side.

The Kartabo specimens were obtained by sifting in the jungle.

Budde-Lund described *P. maculata* from South America, "ad 'St. Nicolas' ad 'Barodero' prope 'Riacho del Oro,'" being the localities given by its describer, who was perhaps as unsuccessful in locating them on the map as I have been. He states that the types are in the Copenhagen Museum. The same species was subsequently found by Kraepelin on orchids imported into Hamburg from Brazil, the specimens being identified by Budde-Lund.

In discussing the character and divisions of the genus *Philoscia*, Budde-Lund (in Voeltzkow, Reise in Ostafrika, II, p. 289), mentions *P. maculata* as one of several species which he places in a new subgenus *Balloniscus*, whose characters, however, he does not mention except to state that the pleopoda are well provided with tracheae. I cannot regard this as a satisfactory or sufficient basis for distinguishing a subgenus.

***Philoscia demerarae*, sp. nov.**

(Plate XXIII, figs. 64-66 incl.)

A single female 4.5 mm. long represents this small species in the collection. It has a well developed and somewhat distended marsupium but this is entirely empty.

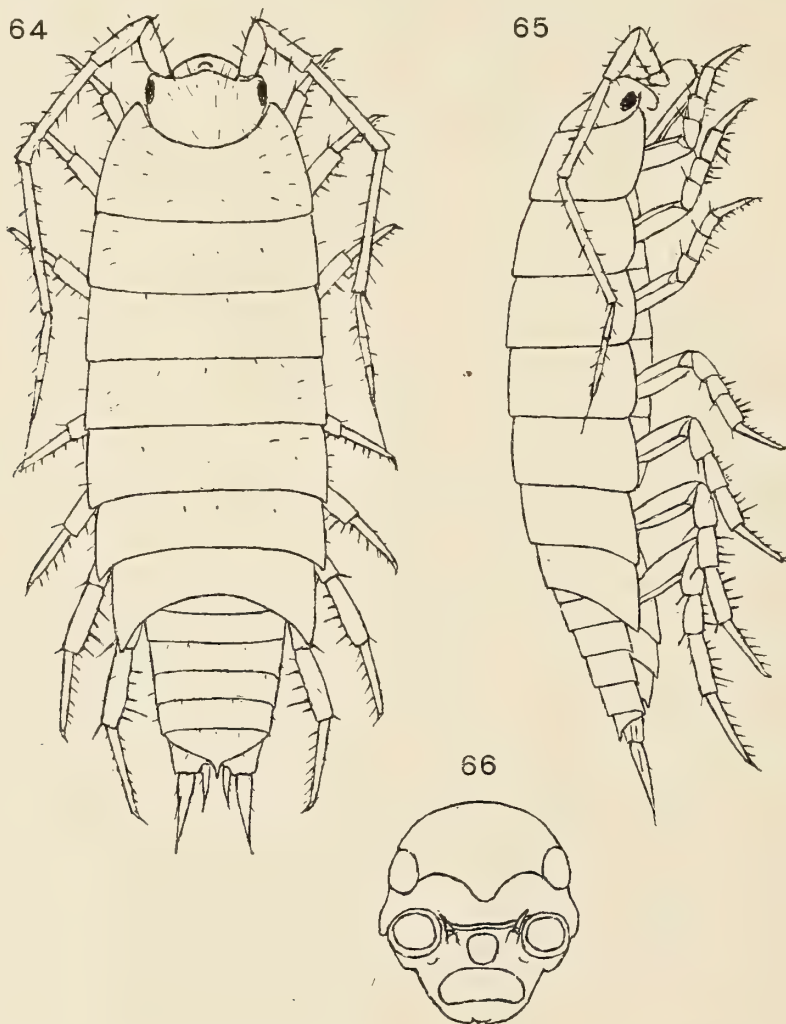


Plate XXIII.—*Philoscia demerarae*, sp. nov.; 64 and 65, female $\times 14$; 66, front of head $\times 23$.

The body is proportionately rather narrow and of elongate elliptical outline when seen from above, the abdomen rather large and long and not very greatly narrower at its anterior end than the last segment of the thorax.

Articulation rather loose, cuticle soft and of tender consistency, making the actual form and proportions of the parts difficult to determine. Surface of body fairly smooth, only a few setose hairs are present on most parts of the body and limbs, except on the antennae, where they are fairly numerous. Color pale purplish brown above with small light (unpigmented) spots on the head and a few larger oval, rounded, or somewhat irregular ones on the dorso-lateral regions of the back. The lower parts and limbs bear a little of the purplish pigment in some places.

Head rounded behind and set well back into the thorax. Seen from above its front outline is sinuous or somewhat three-lobed; the lateral lobes, situated under the eyes, are rounded but extend downward much more than forward or laterally. The most forwardly prominent part of the forehead forms a not very definitely indicated line which, when seen from in front, dips down in the median region in a V-shaped angle. Directly below the angle and between the minute first antennae there is an oval tubercle. The head is not narrowed below the level of the eyes, and the mouth parts form a large mass which projects obliquely downward and farther forward than the anterior margin of the forehead, so that its anterior part shows in a dorsal view of the body. Eyes well pigmented but with rather few ocelli, about ten being well formed. Second antennae quite long, reaching to the sixth thoracic segment when strongly drawn back. The flagellum, exclusive of a rather long terminal bristle, is considerably shorter than the last segment of the peduncle. Its first article is the longest, the second somewhat the shortest (the terminal bristle not being included).

First five thoracic segments with the posterior lateral angles rounded off; the sixth and seventh have them sharp. Only fifth (to a slight extent), sixth and seventh have this angle extended back. Legs long with fairly long and strong spines.

Abdomen only moderately tapered. The posterior angles of segments three, four and five are only extended into insignificantly small, appressed points which are hardly noticeable in a dorsal view. Telson wide and short, its sides slightly sinuously curved and its apex strongly acuminate. The basal segments of the uropoda, as well as the external branch of the same, has a furrow on the external aspect. The basal segment is short, not exceeding the tip of the telson; the branches are also short and rapidly tapered, bearing short bristles at their tips.

The type and only specimen was collected in the jungle at Kartabo by sifting. While a full description of the species must await the collection of more material, it seems quite distinct from the other two species here described, and I have been unable to identify it with any previously described form. No collector's number or notes accompany the specimen.

Family LIGYDIDAE

Ligyda platycephala, sp. nov

(Plate XXIV, figs. 67-71 incl.)

This species resembles the well known and widely distributed *L. exotica*

(Roux) 1828, of the sea coasts of most tropical countries, in the soft, weakly articulated body and the posteriorly tapering outline of the same when seen from above, but it has the abdomen proportionately even smaller than in *L. exotica*, though the thorax is more oblong and less oval in outline.

It will suffice to mention the remaining differences between this species and *L. exotica*. If we may judge by the specimens available, it is considerably smaller; the largest one (a female with well developed marsupial plates bearing a considerable number of rather large eggs or embryos) is a little less than 18 mm. long. The largest male is about 16.5 mm. long. The colors are brighter and more variegated, though due to similar minute irregularly stellate or

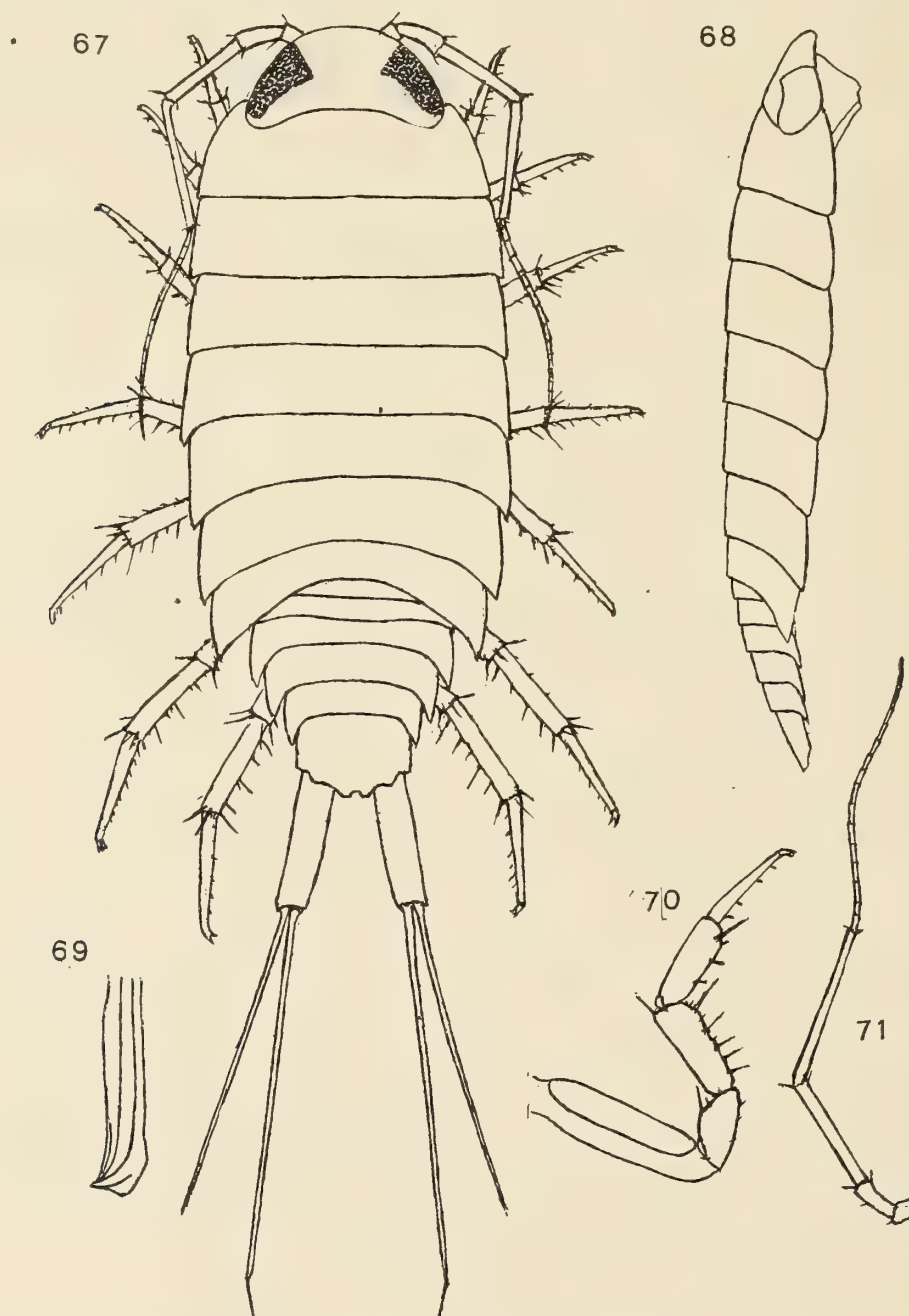


Plate XXIV.—*Ligyda platycephala*, sp. nov.; 67, female $\times 4.5$; 68, side view of body of same $\times 4.5$; 69, tip of styloid appendage of pleopod of male $\times 14$; 70, first leg of male $\times 9$; 71, second antenna of male $\times 5.6$.

branching blackish pigment spots on a yellowish ground color. They are however so distributed in the present species as to form a distinct, broad, blackish median stripe on both the thorax and abdomen, and on the thorax also a series of large, somewhat rectangular obliquely placed blackish spots at the junction of the epimeral portion of the segments with the main portion. These give the appearance of lateral longitudinal dark stripes when not too closely inspected; between these lateral and the median stripes there are on each side one or two small transverse dark markings on the rear edges of the thoracic segments. Elsewhere on the upper parts, as well as below and on the legs, the minute pigment spots are more thinly scattered and do not much obscure the strongly yellowish ground color. The body surface is very smooth, exhibiting no granulation or minute tuberculation on magnification.

The head is much longer and is rather flattened, exhibiting in a dorsal view a strongly convex anterior border and a concave posterior border that is considerably set back into the thorax. The eyes are more elongate and much less bulging. The second antennae are shorter than in *L. exotica*. They are longer in the male specimens where they reach to or even a very little way along the abdomen when well drawn back, than in the females, where they can only reach the sixth or seventh thoracic segment. (The male specimens have 16 or 17 articles on the flagellum, the females 15 or 16, but the male has the peduncular part more elongated than the female).

The thoracic segments differ from those of *L. exotica* in having the epimera smaller and completely fused with the main portion in both sexes. Their posterior corners are angular; the last three sharply so; the others a trifle rounded at the apex. The legs are long and well developed. No sexual differences were found in the structure of the first leg (fig. 70 would represent the first leg of either sex) which much resembles that of the female *exotica*.

This species differs greatly from *L. exotica* in the peculiar outline of the rear end of the telson. It lacks the backwardly directed points at the lateral corners and on the median line; the former are merely bluntly angular, and at the median line there is a small notch between two small obtuse projections.

The styloid appendages of the pleopoda of the male are very straight and slender and reach nearly to the end of the telson. Each process has a broad shallow groove along its ventral aspect. As the tip is approached the sides of the groove draw together, and curving toward the median side join to form a short obliquely projecting claw-like point (fig. 69). In the female the uropoda, inclusive of the inner branch, which is the longest, project beyond the telson a distance about equal to two-thirds the length of the body and head; this measurement is exclusive of a fairly long movable spine or bristle borne on the end of the inner branch. In the male the uropoda are proportionately a little longer than in the female.

Seven specimens of this species are included in the collection. The type, a female 15.4 mm. long, and one male specimen are recorded as found in a damp forest; two others (collector's number 201146) as "land isopods from dead wood" the others simply as "land isopods" or without data.

Ligyda richardsonae Pearse, 1915 (Proc. U. S. Nat. Mus. XLIX, p. 549, fig. 9) from the Sierra Nevada of Santa Marta, Colombia, resembles this species in its forest habitat (though this is at a high altitude, 3800 feet) and in many

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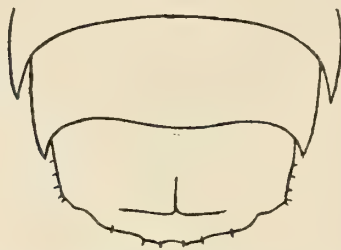


Plate XXV.—*Ligyda richardsonae* Pearse, 1915; 72, outline of rear end of abdomen (dorsal) view. Sketch by Mr. C. R. Shoemaker from cotype in U. S. Nat. Museum. Introduced for comparison.

important characters. Several discrepancies however stand in the way of referring these specimens to his species, notably the fact that the rear border of the telson in his species is rather evenly arcuate with only very slight indications of the distinct toothing and notching of the present form. A sketch drawn from a cotype of Pearse's species in the U. S. National Museum, kindly made for me by Mr. C. R. Shoemaker of that institution, confirms the existence of a marked difference in this respect. It is reproduced in Plate XXV, fig. 72 of this article.

SUPPLEMENT

Additional species of family ONISCIDAE.

***Pentoniscus exilis*, sp. nov.**

(Plate XXVI, figs. 73–77 incl.)

The single specimen in the collection is far from being adequate for a study of this species, whose minute size and delicacy of structure place unusual difficulties in the way of properly describing and illustrating it.

The individual is a female without a well developed marsupium. It measures only 1.95 mm. long in a nearly straightened position of the body and while perhaps not fully grown, the fairly deep pigmentation and general characters of the specimen do not indicate any great degree of immaturity, and the species is evidently an exceedingly minute one.

The body is rather elongate, more so actually than appears to be the case, as the epimeral parts of the segments are considerably developed, increasing its apparent width. Its surface is covered with small tubercles arranged on most of the thoracic segments in two rows, the anterior row being irregular and consisting of about twelve larger tubercles; the posterior row (situated along the rear margin) contains about seventeen tubercles. On the first thoracic segment the tubercles form three (on the lateral parts four) rows, and on the head the tubercles are smaller and quite numerous. The upper parts of the specimen are brown with small light markings; the lower parts and legs are unpigmented.

The head is fairly large and wide and somewhat set back into the thorax. The eyes are well pigmented, but the ocelli are rather indistinct, so that their number, which is evidently small, is difficult to determine. The mouth parts project prominently, not only downward but in a forward direction. The

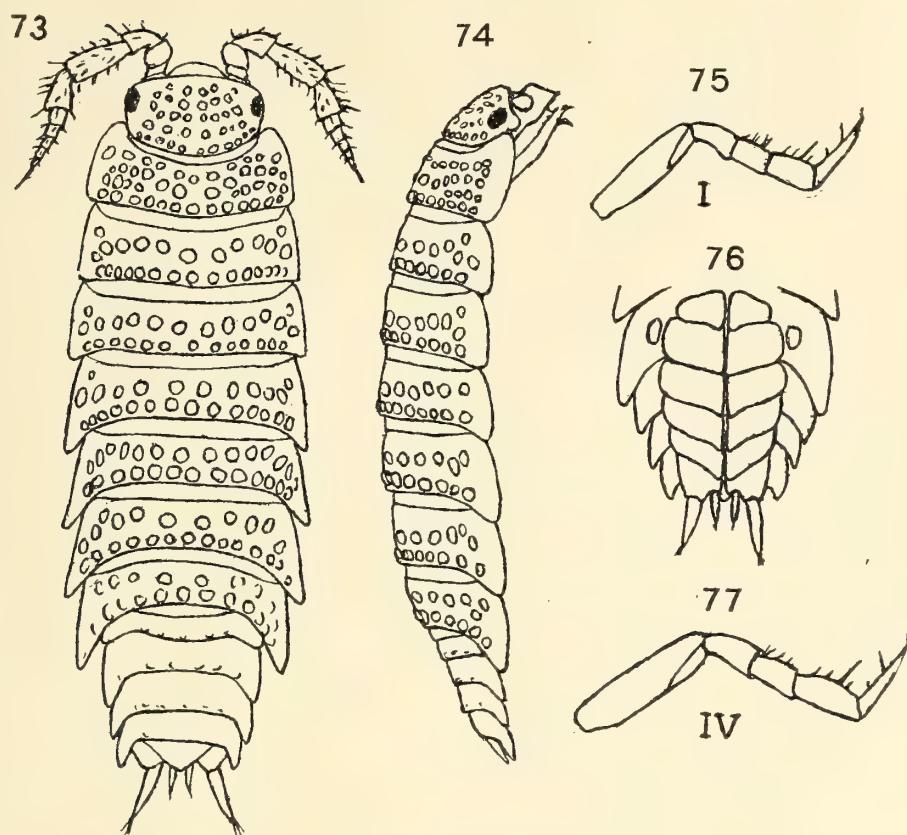


Plate XXVI.—*Pentoniscus exilis*, sp. nov. 73 and 74, female $\times 34$; 75, first leg of female $\times 56$; 76, lower aspect of abdomen of female $\times 34$; 77, fourth leg of female $\times 56$.

second antennae are large, reaching well along the second segment of the thorax, and are covered with short stiff hairs. The segments of the peduncle are rather short and fairly stout, the flagellum is tapering and consists of five segments, decreasing in diameter, the last one bearing a very stout though rather short terminal bristle.

The posterior lateral angles of the thoracic segments are extended back to a successively increasing extent, but the apices of the angles are in no case actually sharp. The specimen lacks some of the legs; none of the last three pairs are preserved, but those of the anterior four pairs that are present show them to be rather long and provided with but few spines. The abdomen forms about one-quarter of the total length and is considerably narrower than the thorax. Its third, fourth and fifth segments have the posterior lateral angles considerably extended backwards. The telson is small, triangular, and somewhat wider than long; its apex hardly projects farther back than the produced angles of the fifth abdominal segment. The basal joint of the uropoda is large and wide; the branches are terete, tapering, and proportionately small (the inner ones especially so), and bear short, terminal hairs.

The only specimen bears no collector's number, but according to the label was collected by sifting in the jungle.

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INDEX TO

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1927

Index

- Abary River, British Guiana, 187
 Ancanthocephala, 56
 Acarina, 62
 Acawoios, 192
 Accipitriformes, 147, 163
 Achirus, 116, 118
 fasciatus, 116, 118
 Aconophora *compressa* Walk., 243-244, 271,
 276, 281, 283, 284
 (Pl. I, fig. 9), 234
 Aconophoroides *gladiator* (Walk), 243, 273,
 276, 277, 281
 Acqueero, 35
 Acrididae, 45, 67-68
 Acridiides, 67-68
 Acrocercus, 93
 Acroceridae, 96
 Actitis *macularia*, 149, 160
 Actinophrys, 53
 Actitis *macularia* (Linné), 142
 Aeria, 84
 Aeshnidae, 73
 Aethalion, 265, 281
 reticulatum Germar, 265, 281
 var. *albo-nervosum* Fowler, 265
 (Plate I, fig. 11), 234
 Ageniosus, 111, 121
 marmoratus, 121
 Ageronia, 87
 Agouti, 180
 Agouti, 50, 175, 176, 180
 Agrionidae, 74
 Agromyzidae, 98
 Akawai Indians, 193
 Alaudidae, 148
 Albite, British Guiana, 16
 Alcedinidae, 164
 Alciformes, 147
 Aleurodidae, 78
 Algae, British Guiana, 23
 blue-green, 23
 brown, 23
 diatoms, 23
 green, on hairs of sloths, 23
 purple, in stomachs of puffers, 23
 Aliku, 41
 Allamandas, 39, 40
 Alouatta, 47, 48, 50, 51, 183
 Alumina, British Guiana, 17
 Amastris, 251-252, 273, 275, 276, 281, 283,
 284, 285
 elevata Funkh., 251, 273, 275, 276, 281
 283, 284, 285
 (Pl. VI, fig. 5), 264
 funkhouseri sp. nov., 251-252
 (Pl. III, fig. 9), 246
 vismiae sp. nov., 252, 275, 281
 (Pl. IV, fig. 4), 254
 Amatidae, 81, 82
 Amatuk, B. G., 295
 Amazon, Mealy, 142
 Amazona, 48, 142, 154, 163
 dufresniana, 154
 farinosa, 48, 142
 Amazons, 186
 Amblycephalidae, 135, 139
 Ameiva, 46, 50, 64, 68, 128, 129, 130, 131-
 132, 134
 Amitermes, 294, 297, 304, 315, 430-432
 (*Amitermes*), 430-432
 excellens, Silvestri, 294, 304, 315, 431-
 432
 description, 431-432
 (Fig. 83), 431
 Amoebae, 52
 Amphibia, 51, 121-125
 Amphibians, British Guiana, 51, 121-125
 enemies of, 123
 Amphipoda, 59
 Amphisbaenidae, 134
 Amphisbena, 128, 129, 131
 Ampullarius, 57
 Anableps, 115
 Anacardium, 31, 39
 occidentale, 39
 rhinocarpus D. C., 31
 Anaconda, 135, 138
 Anastomus *anastomus*, 120
 Anatidae, 162
 Ancistrus, 120
 Angularitermes, 297, see also *Nasutitermes*
 Anhinga, 112, 152, 153
 anhinga, 152, 153
 Anhingidae, 162
 Ani, 165
 Animal Phyla,
 found at Kartabo, 43
 relative abundance at Kartabo, 42, 44
 (Fig. 8), 42
 Anis, 68, 142
 Anisitsia *notata*, 120
 Anatto dye, 187
 Annandale, Mr. Nelson, 267
 Annulata, Kartabo, British Guiana, 43, 56-
 57
 Anolis, 46, 128, 129, 130, 131, 132, 133
 (Fig. 12), 128
 Anoplops *rufigula rufigula*, 143, 155
 Anoplotermes, 294, 299, 304, 315, 420-428
 (*Anoplotermes*), 304, 315, 420-427
 banksi sp. nov. 304, 315, 423-424
 description, 423-424
 (Fig. 77), 422
 brevipilus sp. nov., 304, 315, 424-
 425
 description, 424-425
 (Fig. 78), 425
 cingulatus, 294, 421
 meridianus nom. nov., 299, 304,
 315, 421
 morio (Latr.) Silvestri, 299, 421
 nigripunctatus sp. nov., 304, 315,
 426-427
 description, 426-427
 (Fig. 80), 426
 silvestri sp. nov. 304, 315, 421-423
 description, 421-423
 (Fig. 76), 422
 subterraneus sp. nov., 304, 315,
 425-426
 description, 425-426
 (Fig. 79), 425
 (*Speculitermes*), 304, 315, 427-428
 arboreus sp. nov. 304, 315, 427-428
 description, 427-428
 (Fig. 81), 426
 Anseriformes, 146, 147, 162
 Ant, 33, 45, 46, 49, 50, 51, 105-107
 Army 46, 50, 61, 105-107
 attendance on Membracids, 271-273,
 279
 Azteca, 47, 50
 Giant Black Solitary, 46
 red, 46, 47, 48

- small brown, 45, 47
 stinging, 33
 Antbear, 182
 Ant-bird 27, 47-48, 50, 62, 63, 64, 71, 143,
 148, 166, 167
 Cinereous, 47
 Gray-breasted, 143
 Pygmy, 48, 143
 Rufus-bellied, 143
 Spotted-tailed, 143
 White-fronted, 50
 Woodcock 143
 Antcatcher, 143
 Rufus-fronted, 143
 White-fronted, 143
 Antcreeper, 47, 143
 Schomburgk's, 143
 Spot-winged, 47
 Anteater, 176, 182-183
 silky, 183
 tamandua, 176, 182
Anthocoridae, 75, 76
Anthomyiidae, 98
Anthophoridae, 102-103
Anthribidae, 93
Anthrocothorax violicauda, 154
 Antigua, W. I., 295
 Ant-thrush, 143
 Black-faced, 143
 Ant-lions, 79
 Antwood, 33
 Antwren, 48, 143
 White-bellied, 143
 White-flanked, 143
Anura, 122
Aphetea affinis sp. nov. 252-253, 273, 276,
 281
 (Pl. III, fig. 4, 4a), 246
Aphididae, 78
 Aplite, British Guiana, 16
 Apoda, 121
Ara, 48, 142, 163
 chloroptera, 48
 macao, 142
 Aracari, Green, 142
 Arachnoidea, 60-63
Aradidae, 76
Aramididae, 160
Aramides cajanea, 149, 153, 159
Araneae, 62
 Arapaima, 109
 Arawak Indians, 192
Arcella, 52-53
Arctiidae, 81, 82
Ardea cocoi, 152, 162
Ardeidae, 162
Ardeiformes, 146, 162
 Arepo Savanna, Trinidad, 295
Argiope, 47
Argulus, 58
Armadillidae, 59
Armadillidium, 467
 caelatum Miers, 467
 vulgare (Latreille), 467
 Armadillo, 183
 eight-banded, 183
 giant, 183, 184
 (Fig. 17), 184
 nine-banded, 183
Armadillo murinus Budde-Lund, 466
Armitermes, 80, 297, 303, 313, 314, 367-375
 albidus (Hagen), 303, 314, 367-369
 (Fig. 49), 368
 grandidens sp. nov., 303, 314, 373-374
 description, 373-374
 (Fig. 52), 373
 minutus sp. nov., 303, 314, 374-375
 description, 374-375
 (Fig. 53), 374
 percutiens sp. nov., 303, 314, 369-371
 description, 369-371
 (Fig. 50), 370
 teevani sp. nov., 303, 314, 371-372
 description, 371-372
 (Fig. 51), 372
 Armored Catfish, 110, 113
 Aroid lily, 23
 Arrancanduck, 35, 40
Arremon taciturnus, 157, 167, 171
Arrhinotermes, 298, 344
 Arthropoda, Kartabo, British Guiana, 43,
 58-107
 Arthrostraca, 59
Artiodactyla, 174, 185
Arundinicola leucocephala, 155
Ascalaphidae, 79
Asilidae, 45, 46, 69, 97
Aspidospermum excelsum Benth, 30
Astrocaryum tucuma Mart, 35
Asturina nitida, 152
 Asuncion, Paraguay, 295
Ateleus, 183
Atelophus, 123
Atelopus, 55, 124
 flavescens, 124
Atelura, 65
Atractus, 135
Atta, 105, 122
Atticora fasciata (Gmel.), 144, 151, 170
Attidae, 48
Attila, 45, 129, 144, 152, 156, 170
 spadicens spodiostethus, 152, 156
 Spix's, 144
 thamnophiloides Spix, 144, 152
 uropygialis, 152
Atyidae, 59
Augochlora, 102
Augochloridae, 102
Auris distaeta, 57-58
Automolus, 48, 50, 130, 155, 168
 cervicalis, 155
 infuscatus, 48, 50, 130
 turdinus macconnelli, 155
 Aves, British Guiana, 1, 2, 39, 40, 45-51,
 62, 66, 77, 88, 140-173, 195-227
Awous, 116
Azteca, 78, 273
 paraenis Ferrel, 273
 Bailey, Dr. I. W., 293, 399
Balloniscus Budde-Lund, 496
 Balsam, 187
 Bamboos, British Guiana, 37
 (Fig. 6), 36
 Bananaquit, Guiana, 145
 Banks, N., 294, 298, 340, 357, 375, 379, 392,
 416, 424, 430, 454, 455
 Barakara, B. G., 295
 Barbet, Black-spotted, 142, 165
 Bartica District, British Guiana, 1, 5, 7, 192
 295
 map, 4, 6,
 see also Kartabo, British Guiana
Basidentitermes, 432
 Bat, 61, 173, 176, 178
 house, 178
 river, 178
 sac-winged, 178
 vampire, 176, 178
 white jungle, 178
 Batoidea, 112
 Bauxite, British Guiana, 17
 Beach grass, British Guiana, 25
 Bee, 40, 41, 46, 47, 49, 50, 99-107
 Giant Metallic Blue, 50
 Medium Metallic, 46
 Beebe, William, 1, 229, 231, 293, 416, 461,
 470, 473, 477, 486
 Beebe, William,
 Studies of a Tropical Jungle; One
 Quarter of a Square Mile of Jungle

- at Kartabo, British Guiana, 1-193
for paged outline see "Studies of a Tropical Jungle"
(Plates A, B. Figs. 1-17 incl.), 4, 6, 8, 18, 24, 28, 34, 36, 38, 42, 64, 86, 106, 128, 137, 161, 172, 182, 184
- Beebe, William
The Variegated Tinamou, 195-227
(Plates A, B; Figs. 18-22 incl.), 196, 198, 202, 206, 211, 216, 225
for paged outline see "Tinamou"
- Beetle, 46, 47, 49, 88-93
Buprestid, 47
Rhinoceros, 49
Scarab, 48
Small White-Spotted, 46
- Bellicositermes*, 298, 299
Bellucia grossularioides Triana, 39-40
Belonidae, 115
Bembecidae, 105
Benda, 41
Beryl, British Guiana, 17
Bête rouge, 200, 214
Biara, 109
Bibionidae, 95
Bignonias, 40
Birds, British Guiana, 1, 2, 39, 40, 45-51, 62, 66, 77, 88, 195-227, 140-173
breeding records, 153-158
food of, 149-152
migrants from North America, 145-146
- Birds,
of New York State and of Kartabo,
British Guiana, 146-148
- Bittern, sun, 160
Bivalves, 58
Bivibranchia protractila, 120
Blackbird, 145
Blanchard, E., 455
Blattidae, 46, 66
Blood-leaf, 40
Boa constrictor, 130, 135, 136, 138
Boas, 130, 135, 136, 138
Bobolink, 146
Bocydium globulare (Fabr.), 257, 278, 282, 285
Bodkin, Mr. G. E., 293, 372, 381, 419
Boethoos, 249-250, 272, 273, 276, 277, 282, 283, 284
cinctata sp. nov., 249-250
(Pl. IV, fig. 5), 254
distinguenda Fowler, 250, 268, 282
globosa sp. nov., 250, 268
(Pl. III, fig. 10), 246
reticulata (Fabr.) 250-251, 268, 272, 282, 284
(Pl. VI fig. 7), 264
testudinea, 273
- Boidae*, 135, 138
Bolbonota, 241-242, 267, 270, 271, 277, 280, 281, 284
aspidistrae sp. nov., 241, 270, 271, 280, 281
(Pl. I, fig. 7; Pl. II, fig. 6; Pl. VI, fig. 1), 234, 238, 264
corrugata Fowler, 242
inaequalis (Fabr.), 242, 281, 284
pictipennis Fairm., 242
- Bolivar, 456
Bombardier beetles, 89
Bombidae, 102
Bombycillidae, 148
Bombyliidae, 96
Boneset, Orinoco, 39
Book lice, 72
Boone, P. L., 462, 471, 473, 502
Bopyridae, 59, 461, 481-484
Borecus pinnatus, 66
Bosmina, 58
- Bothrops*, 136, 138, 139
bilineatus, 139
lanceolatus, 139
Bovianders, 191, 192, 193
Brachyplatystoma, 111, 113, 121, 476, 480
rousseauxi, 121
vallianti, 121
Brachypodidae, 181
Brachyrura, 60
Braconidae, 100-101
Bradley, Prof. J. C., 293, 381
Bradypus, 181
(Fig. 16), 182
Brandt, J. F., 465, 466, 502
Brassolidae, 83, 85
Brenthidae, 93
Brevicipitae, 123
Brindley, Mrs. H. H. (Maud D. Haviland),
Membracidae of Kartabo, Bartica District, British Guiana. With descriptions of New Species and Bionomical Notes, 229-290
(Fig. 23; Plates I-VI incl.), 232, 234, 238, 246, 254, 260, 264
for paged outline see *Membracidae* of Kartabo
- Bristles (termites), 299
British Guiana, 5, 7,
see also Kartabo, B. G. and
"Studies of a Tropical Jungle"
Climatological station, 7
diamonds, 17, 192
Dutch, 37, 39, 44, 186-193
ecology, 1-193
gold, 17, 192
Hindus, 192
history, 186-193
Indians, 27, 28, 31, 32, 35, 40, 41, 59, 78, 110, 114, 126, 158, 187, 192, 193
penal settlement, 7, 192, 193, 296
Portuguese, 187
Spaniards, 186-193
- British Guiana, ecology of,
see "Studies of a Tropical Jungle"
- British Guiana Kartabo Station of the New York Zoological Society,
see Kartabo Station
- Bromeliads, British Guiana, 26
microscopic life in water of, 52-53, 58, 74, 95
- Bruchidae*, 92
Brues, C. T., 293, 456
Brycon falcatus, 120
Bryophyllum pinnatum (Lam) Kury, 39
Bryozoa, 56
Bucco, 143, 154, 166
capensis, 143, 154
macrorhynchus, 154
Bucconidae, 166
Buckley, S. B., 456
Buckton, 274, 284
Budde-Lund, G., 465, 466, 467, 484, 490, 491, 493, 494, 496, 502
Bufo, 58, 62, 63, 64, 89, 124, 125
gutatus, 125
marinus, 58, 62, 63, 64, 124, 125, 139
typhonius, 64, 125
*Bufo**nidae*, 121, 122
Bull-heads, brobdignagian, 108
Buprestidae, 91
Burmeister, H., 456
Bushbird, 50, 143
Ashy-backed, 143
Cinereous, 143
Mouse-colored, 50, 143
Bush master snake, 135, 139
Bush-rope Town, British Guiana, 187
Buthidae, 60
Butorides striata, 149, 150, 151, 153
Butterflies, 41, 46, 47, 48, 51, 80-88

- Byrrhidae*, 91
Cacicus, 45, 145, 157, 173
 cela (Linné), 145, 157
Cacique, 45, 145, 148
 Great Black, 145
 yellow-backed, 145
Caddis flies, 80
Caiman, 111, 127
 niger, 127
 sclerops, 127
Caique, 142, 145
 Black-headed, 142
 Great Black, 145
 Yellow-backed, 145
Cairina, 162
Caladiums, 29
Caligo, 85
Callichthyidae, 113
Callichthys callichthys, 119
Callitrichidae, 183
Calotermes, 326
 brevis, 326
Calvifrons calvus, 156, 170
Camaria, B. G., 295
Campephilus, 154, 155, 166
 melanoleucus, 155
 rubricollis, 154
Camponotus femoratus Fabr., 273
Campsurus, 73
Campylenchia, 235–236, 270, 273, 275, 276, 281, 283, 284
 nutans (Germ.), 235–236, 270, 273, 275, 276, 281, 283, 284
 (Pl. I, fig. 6; Pl. VI fig. 3), 234, 264
Campylopterus largipennis, 142, 154
Campylorhampus, 143, 150, 155
 trochilirostris procurvoides, 143, 150, 155
Canidae, 178–179
Canister Falls, B. G., 295
Canoes, 32, 33
 British Guiana Indian, 32
 wood for, British Guiana, 32, 33
Canthoridae, 92
Capito niger (Mull.), 142, 154
Capitonidae, 165
Capridae, 76
Caprimulgidae, 164
Caprimulgus, 45, 154, 164
 nigrescens, 154, 164
Capritermes (Neocapritermes) 294, 304, 315, 435, 445–450
 angusticeps sp. nov., 294, 304, 315, 447–449
 description, 447–449
 (Fig. 91) 448
 bodkini, 294, 304, 315, 445–447
 description, 445–447
 (Fig. 90), 446
 cingulatus, 294
 planiceps sp. nov., 304, 315, 449–450
 description, 449–450
 (Fig. 92), 450
 saltans, 435
Capybara, 180
Carabaya Mts. Peru, 295
Carabidae, 89
Caracara, 47, 49, 142
 Red-throated, 47, 142
 Yellow-throated, 49
Carapa guianensis Aubl., 30
Cardisoma, 45
Caribs, 191
Carnegiella strigata, 119
Carnivora, 174, 178
Caryothraustes canadensis, 157, 171
Cashew, wild, 31, 39, 40
Casmerodius, 162
Cassava, 27, 37, 41
Cassia multijuga Rich, 31, 40
Cassidix oryzivora oryzivora (Gmel.), 145, 157, 173
Castniidae, 81, 82
Castries, St. Lucia, W. I., 295
Cat, 175, 176, 179
 jaguar, 179
 jaguarondi, 175, 177, 179
 margay, 176, 177, 179
 ocelot, 179
 puma, 179
Caterpillar flower, 41
Catfish, 58, 59, 108, 109, 110, 112–113
Cathartes aura urubitinga, 47, 142
Cathartidae, 163
Cathartiformes, 147, 163
Catopsilia, 84
Cavitermes subg. nov., see *Mirotermes*
Cebidae, 183
Cebus apella apella, 51, 183–185
Cecidomyiidae, 94
Celeus, 143, 150
 hellmayri, 150
 undata (Linné), 143
Cenotropyx, 129
Centipedes, 63–64
Centrinae, 102
Centris, 102
Centropyx, 129, 131
Centruroides felinus sp. nov., 257, 276, 281, 285
 (Pl. IV, fig. 6), 254
Ceophloeus lineatus lineatus, 143
Cephonia clavata, 281
Cerambycidae, 93
Ceratinidae, 102
Ceratium, 53
Ceratocampidae, 81, 82
Ceratophrys, 123
Ceratotermes, 432
Cercomacra, 155
 tyrannina saturator, 155
Cercopid Bug, 49
Cercopidae, 77
Cercopithecus, 183
Cercropia palmata, 33
Ceresa vitulus (Fabr.), 253, 268, 277, 282
Certhiidae, 148
Cervidae, 185
Cestodes, 55
Cetacea, 174
Cetonids, 89
Chachalaca, Little, 141
Chactidae, 60
Chaemepelia, 142, 153
 griseola, 153
 talpacoti, 142, 153
Chaetopoda, 56
Chaetura, 45, 47, 142, 154, 164
 brachyura, 154
 spinicauda, 164
Chalceus macrolepidoptus, 118
Chalcididae, 100
Chalcinus rotundatus, 117, 118, 119
Chamaepelia, 159
Chamberlain, R. V. 293, 456
Chapman, Dr., 140
Chaquimayo, Peru, 295
Characidae, 113
Charadriidae, 159
Charadriiformes, 146, 147, 159
Charadrius collaris (Vieill), 142
Chatterer, 144
 Cayenne, 144
 Pompadour, 144
Chelanops, 61
Chelidoptera, 143, 154, 166
 tenebrosa tenebrosa (Pall), 143, 154
Chelifer, 61
Chelifera, 461, 469–470
Chelonia mydas, 126
Chelonidae, 126

- Chelydidae*, 127
Chelys fimbriata, 127
Chiromachearis manacus, 156
Chironectes, 112, 178
Chironomidae, 95
Chiroptera, 174, 178
Chlamydomonas, 52, 53
Chlorida festiva, 93
Chloroceryle, 142, 152, 154, 164
 amazona, 154
 americana americana, 142
 a. aenea, 154
 inda, 152, 154
Chloronerpes, 71, 149, 150
 flavigula, 149, 150
Chlorophanes spiza spiza (Linné), 145
Choloepus, 182
Chondrohierax palliatus, 152, 153
Chordata, Kartabo, British Guiana, 43, 107-186
Christmas-tree plant, 37
Chrysididae, 101
Chrysocestis, 83
Chrysomelidae, 46, 88, 92
Chrysopidae, 48, 79
Chrysotrogon, 142
 violaceus violaceus, 142
Chubb, 153, 195
Cicada, 45, 46, 77
Cicadellidae, 76-77
Cicadidae, 77
Ciccaba, 152, 154, 163
 huhula, 152
 superciliaris macconnelli, 152, 154
Cichla ocellaris, Bloch and Schneider, 476
Cichlidae, 115
Cicindelidae, 89
Cicinnidae, 81
Ciconiidae, 162
Cilia (termites), 299
Cinosternidae, 126
Cinosternum scorpioides, 126
Cinura, 65
Circoniscus, 462, 466, 467, 488-491
 gaigei Pearse, 462, 467, 488-491
 description, 488-491
 (Plate XVIII, figs. 43-51 incl.), 489
 spinosus (Collinge), 466
Cissopis, 172
Cistelidae, 92
Citrus medica acida, 39
Clays, British Guiana, 16
Cleare, Mr. L. D., 293, 318
Clelia, 130, 135, 136, 138
 petolaria, 138
Cleridae, 91
Click beetles, 91
Clusia, 40
Cnemidophorus, 129, 130, 131-132, 134
Coati, 177, 179
Coatimundi, 64, 130
Coccidae, British Guiana, 39, 45, 47, 48, 78
Coccinellidae, 90-91
Coccocypselum, 29
Coccopsis gularis, 157
Cochlearius cochlearius, 149, 152, 162
Cockchafer, 89
Cockreeou, 35
Cocoa, Wild, 40
Cocconut Palm, British Guiana, 35
Cocos nucifera L., 35
Coecilidae, 121
Coelenterata, Kartabo, British Guiana, 43, 54
Coelioxys, 103
Coendou, 180
Coephleus lineatus, 47
Coereba chloropyga guianensis (Cab.) 145, 157, 171
Coerebidae, 148, 171
Colaenis, 87
Coleoptera, British Guiana, 51, 88-93
Collembola, 65-66
Collinge, W. E., 466, 467, 502
Colomesus psittacus, 117, 118, 119, 120
Colopteryx galeatus (Bodd), 144, 148, 156
Color Standards and Nomenclature, Ridgway's, 21-22
Colubridae, 135, 139
Columba, 153
 purpureotincta, 153
 speciosa, 153
Columbidae, 159
Columbiformes, 146, 147, 159
Columbus, Christopher, 186
Comacuballi lianas, 29
Combretum laxum Loebl., 41
Comstock, Mrs. A. B., 391
Congo Pump (British Guiana tree), 33
Conopidae, 97
Conopophagidae, 148, 167
Constrictotermes, 297, see also *Nasutitermes*
Convexitermes, 297, see also *Nasutitermes*
Convolvulus, 39
Copaiba, 187
Copaifera pubiflora Benth., 32
Copepoda, 58
Cophias, 129, 130, 131, 132, 134
 flavescens, 130
Coprises, 89
Coptotermes, 294, 297, 303, 313, 344-346
 marabitanas, 297, 303, 313, 344-346
 description, 344-346
 (Fig. 37), 343
 testaceus, 294, 303, 421
Coptotermittinae, 313, 344-346
Coraciiformes, 147, 164
Coragyps, 163
Coral snake, 135, 138
Coraltus caninus, 137, 138,
 (Fig. 13), 137
Corapipo gutturalis, 156
Cordulidae, 73
Coreidae, 75
Cormorants, 162
Cornitermes, 294, 297, 303, 313, 363-367
 (*Labiatermes*), 363-365
 acignathus, 294
 labralis Holmgren, 303, 313, 363-365
 description, 363-365
 (Fig. 47), 363
 (*Cornitermes*), 365-367
 pugnax sp. nov., 294, 303, 313, 365
 description, 365-367
 (Fig. 48), 366
Corona, 58
Correbia, 82
Corrodentia, 72
Corundum, British Guiana, 17
Corvidae, 148, 173
Corydoras punctatus, 119
Corythopsis torquata anthoides, 151, 155, 167
Cossidae, 81
Costus spicatus, 84
Cothurnia, 53
Cotinga, 48, 144, 156, 170
 cayana (Linné), 144, 156
 cotinga, 48
Cotinga, 45, 48, 170
 brain-fever, 45, 170
 purple-breasted, 48
Cotingidae, 148, 170
Cotton, British Guiana, 187
Cotylaspis, 55
Courmelina longicaulis Jacq., 25
Coutoubea spicata Aubl., 25
Cow Island, B. G., 296
Coxipo (Cuyaba), Brazil, 296
Crab, 45, 51, 58, 60

- Land, 45, 51, 58, 60
Crabronidae, 105
 Crabwood, 30
Cracidae, 158–159
Craspedoprion, 144
 olivaceous guianensis, 144
Crax nigra Linné, 141, 153, 159
Creatochanes, 118, 119, 120
 affinis, 118, 119, 120
 caudomaculatus, 118, 119
Creciscus, 149, 153, 159
 exilis, 153
 viridis, 149, 153
 Creeper, 145
 Green Honey, 145
 Turquoise Honey, 145
Crematogaster limata Smith, 273
Crenicichla, 115, 117, 119, 121
 alta, 117
 lugubris, 119, 121
Crepititermes, 297, see also *Mirotermes*
 Crest, Royal Great, 144
 Cricket, 45, 46, 50, 68–71
 Harlequin Jungle, 50, 70
 Large Brown, 45
 Small Brown, 46
 Crocodile, 127
 Crocodilia, 127
Crocodylidae, 127
Crotalus, 135
Crotalidae, 135, 139
Crotophaga, 45, 62, 63, 142, 150, 154, 165
 ani, 62, 142, 150, 154
 major, 150
Cruium, 39
 Crustacea, 58–60, 461–503
 Cryptic *Membracidae*, 281–282
 Cryptocerata, 74
Cryptotermes, 297 (see also *Kalotermes*)
Crypturus, 51, 141, 153, 158
 soui, 153
 variegatus, 51, 141, 153, 195–227
 (see Tinamou, Variegated)
 (Fig. 20), 211
Cubaris, 466
 affinis Miers, 466
 gaigei Pearse, 466
 murina Brandt, 466
Cubitermes, 432
 Cubitus (termite wings) 299
 Cuckoo, 45, 62, 63, 146, 165
 Black, 45, 63
 rufous, 165
 yellow-billed, 146
Cuculidae, 165
Cuculiformes, 147, 165
Culicidae, 94–95
 Curassow, Crested, 141
Curculionidae, 93
Curimatus, 120
 schomburgki, 120
 spilurus, 120
 Curlew, 160
Curucujus, 142
 melanurus melanurus, 142
 Cuyuni River, British Guiana, 1, 5, 7, 17,
 19, 20, 21, 22, 187, 296
 Gold mining, 17
 Cuyuru Palm, 35
Cyanerpes, 157, 171
 caeruleus, 157
 cyaneus, 157, 171
Cyanocompsa rothschildi, 157
Cyanocorax, 64, 150, 157, 173
 cayana, 150, 157
Cyclopes, 71, 183
Cyclops, 58
Cylindrotermes, 297, 304, 315, 428–430
 nordenskioldi Holmgren, 304, 315, 428–
 430
 description, 428–430
 (Fig. 82), 429
Cymbilaimus lineatus, 155
Cymbomorpho vaginata (Germ.), 244, 273,
 275
Cymothoa, 468, 478
 henselii (von Martens), 478
Cymothoidae, 59, 461, 462, 473–481
Cynipidae, 100
Cynopotamus, 111, 118, 119, 121
 essequibensis, 118, 119, 121
Cyperus sp., 23
Cyphonia, 253, 278, 282, 284
 clavata (Fabr.) and Fairm., 253, 278,
 282
 nasalis Stal., 253
Cypris, 58
Cypseloides fumigatus, 154
Cystignathidae, 121, 123
Dacnis cayana cayana (Linné), 145, 157
 Dada-nawa, British Guiana, 14–15
 meteorology, 15
 Daddy-Long-Legs, 50, 61
Dalceridae, 81
 Dalina, 32
 Dalli, 33
 Damsel-Fly, 49, 73–74
Danaidae, 83, 84–85
 (Fig. 10), 86
Daphnia, 58
Darnis, 243, 267, 278, 282
 laticornis Fowler, 243, 267, 278, 282
 partita Walker, 243, 267, 278, 282
Dasypodidae, 183
Dasypocta aguti flavescens, 50, 180
Dasypoctidae, 180
Dasypus, 183
 De Geer, C. 456
 Decapoda, 59
 Deer, 175, 185
Dendrexetastes, 143
 rufigula (Less.), 143
Dendrobates, 59, 61, 64, 123, 124, 125
Dendrocincla, 80, 150, 155
 fuliginosa, 150, 155
Dendrocolaptes, 64, 150, 155
 certhia, 150
 plagosus, 155
Dendrocolaptidae, 148, 168
Dendrocygna, 162
Dendroeca aestiva aestiva (Gmel.), 144, 171
Dermestidae, 91
Desmodium, 26
Desmodontidae, 178
Desmodus, 178
 Desneux, J., 456
Dexiidae, 98
Diacrium bicornutum (Hooper) Benth., 26
 Diamonds, British Guiana, 17, 192
Dichropogon poecilonota, 155
Didelphidae, 177–178
Didelphis, 177
Diffugia, 53
Dimorphandra excelsa (Schomb), 30
Dinoponera, 46
Diodia, 25
 Diptera, British Guiana, 51, 94–99
Dismorphia, 84
Diversitermes, 297
Dixidae, 95
 Dog, hunting, 178
 Dog-toothed fish, 109
 Dolichopodid Fly, 49, 50, 97
Dolichopodidae, 45, 49, 97
 Dollfus, A., 466, 467, 484, 502, 503
Dolops, 58
 Dolphin, fresh-water, 175, 185
 Dominica, W. I., 296
Donacobius, 170
 Doodle-bugs, 89

- Doras granulosus*, 120
 Dove, 142, 159
 ground, 159
 jungle, 159
 Talpacoti Ground, 142
 Dragonfly, 49, 73-74
Drepanotermes, 430
Dromococcyx pavoninus, 150, 154
Drosophilidae, 98
Drymobis, 136
 Duka, 35, 39
 Dunoon, B. G., 296
Dupatya, 37
 Dutch in British Guiana, 27, 37, 39, 44, 186-193
 Dutch West India Company, 187-190
Dysithamnus, 143, 155
 mentalis spodionotus, 143
 murinus, 155
 saturninus, 155
Dysticidae, 90
 Eagle, 163
 Earthquakes, British Guiana, 17
 Earthworms, 57
 Earwigs, 72
Echimys, 181
Echinorhynchidae, 56
Eciton burchelli, 50, 61, 105
 Ecology of Kartabo,
 see Studies of a Tropical Jungle; one
 Quarter Square Mile of Jungle at
 Kartabo, British Guiana, by William
 Bebe, 1-193
Ectatomma tuberculatum, 107
 Eels, 109, 110, 114
 Egg,
 of Tinamou, 205-207
 (Fig. 19), 206
 Egret, 145, 162
 Eigenmann, Dr. Carl H., 108
Eigenmannia virescens, 116, 117, 118, 119
 El Dorado, British Guiana, 186
Elaeena, 144, 151, 156
 cristata whitelyi, 151
 martinica flavogaster, 144
 pagana macconnelli, 156
Elainopsis guianensis, 156
Elanoides, 130, 142, 152, 153, 163
 forficatus yetupa, 142, 152, 153
 furcatus, 152
Elaphidae, 135
Elateridae, 91
 Electric eel, 110, 114
Electrophorus electricus, 117, 119, 120, 121
Eleocharis geniculata R. Br., 23
Eleotris, 116, 119, 120, 121
 amblyopsis, 119, 120, 121
 Elephantiasis, British Guiana, 55
Eluma, 467
 caelatum (Miers), 467
 purpurascens Budde-Lund, 467
Emballonuridae, 178
 Emerson, Alfred Edwards: The Termites of
 Kartabo, Bartica District, British
 Guiana, 291-459
 for paged outline see "Termites
 of Kartabo"
 Emerson, Prof. 71, 72, 122
 Emerson, Winifred Jelliffe, 293
Empidae, 97
Empidonomus, 156
 varius parvirostris, 156
Enchenopa, 233-235, 264, 268, 270, 271, 276,
 281, 282, 283, 284, 285
 albidorsa (Fairm.) and Walker, 233, 276
 bifenestrata Funkh., 233, 268, 270,
 271, 281, 284, 285
 (Pl. I, fig. 4; Pl. VI, fig. 2), 234,
 264
 galeata Walker, 258
 lanceolata (Fabr.) and Walker, 233-
 235, 265, 266, 270, 275, 282, 284
 (Fig. 23), 232
 monoceros (Germ.) 235, 268, 276, 281,
 284
 nutans Fowler, 235, 271
 pulchella Funk., 235
Endoiastus, 263-264, 267, 272, 273, 282, 285
 caviceps, 263
 productus Osborn, 263-264, 267, 272,
 273, 282, 285
 (Plate I, fig. 8), 234
Eneopterides, 45, 70-71
Engraulidae, 114
Engystomatidae, 121
Entomostraca, 58
Entylia sinuata, 271
Eperua falcata Aubl., 21
Ephemerida, 73
Ephrata, Surinam, 296
Epiaeschna, 73
Epicaridea, 461, 481-484
Epicrates, 138
Epidendrum fragrans Sw., 26
Epidote, British Guiana, 16
Epiplemidae, 81
Epistylis, 53
Equisetum, 25
Erebus, 82
Erethizontidae, 180
 Erichson, W. F., 294, 456
Erionotis tristis, 155
Erionotus amazonicus, 150
Erotylidae, 90
Erycinid, 47
Erycinidae, 83, 87
Erythrolamprus, 135, 136
Esocidae, 115
 Essequibo River, British Guiana, 5, 7, 15,
 21, 187
 Eta Palm, 35
 Etaballi, 31
Ethelium americanum (Dollfus), 461, 467,
 484-486
 description, 484-486
 (Plate XVI, figs. 27-36 incl.), 485
Eubelinae, 461, 484-486
Euchilotermes, 432
Eucryptotermes, 297
Eueides, 87
Euglena, 53
Euglossa, 46
Euglossidae, 103
Euhamitermes, 430
Eumenidae, 103
Eumops, 178
Eunectes, 111, 135, 136, 138
 Eupekari, British Guiana, 14-15
 meteorology, 15
Euphonia, Violaceus, 145
Euplexoptera, 72
Eupterotidae, 81
Eurypyga helias, 153
Eurypygidae, 160
Entermeres, 294, 298, 299, 375, 376, 379, 381,
 387, 407, 417, 454
 acajutlae, 387
 cavifrons, 417
 cayennae, 379
 debilis, 375, 454
 ephratae, 381
 guayanae, 376
 incola, 299
 martiniquensis, 379
 nigricornis, 407
 parvellus, 294
 Sanchezi, 379
Euterpe edulis Mart, 35
Evaniidae, 101
Evorthodus, 116, 118

- breviceps*, 118
Excorallana berbicensis Boone, 461, 462, 468, 471-473
 description, 471-473
 (Plate VIII figs. 3-8 incl.), 472
Excorallanidae, 461, 462, 471-473
 Fabricius, J. C., 379, 421, 456
 Fairy, Black-eared (bird), 142
Falco, 151, 152
 albigularis, 152
 ruficularis, 151, 152
Falconidae, 163
 Fauna,
 of Kartabo, 42-186
Felidae, 179
Felis cougar, 179
 Felspar, British Guiana, 16
 Fer-de-lance (snake), 138, 139
 Ferry, Captain Anthony, 189
 Filaria, 55
 Fireflies, 91
 Fish, British Guiana, 51, 106, 108-121
 (Fig. 11), 106
Flabellifera, 461, 462, 471-481
Flatbill, 144
 British, 144
 Pelzeln's, 144
 Fleas, 99, 180
Florida caerulea caerulea (Linné), 142
 Flounder, 116
 Flower beetles, 92
Fluvicola pica, 155, 169
 Fly, 45, 46, 47, 48, 49, 50, 51, 94-99, 180
 carrion, 46, 47, 48
 dancing-winged, 48, 51
 deer, 51, 96
 yellow-winged, 46, 48, 49
 hump-backed, 46, 47, 48, 49
 lace-winged, 48
 long-legged, 48
 muscid, 49, 50
 robber,
 large hairy, 46, 47
 small brown, 45, 48, 49, 40
 warble, 180
 Flycatcher, 45, 144
 Kiskadee Tyrant, 45
 Oily, 144
 Pitangua, 144
 Spotted Tody, 144
 Whispered, 144
 Yellow-vented, 144
 Flycatcherlets, 148
 Flying fish, 110, 114
 Folsom, J. W., 293, 456
 Fontanelle (termites), 300
 Forests British Guiana, 15, 27-36
Formicariidae, 45, 148, 167
Formicarius, 63, 71, 143, 150, 151, 155
 colma, 143, 150, 151, 155
 moniliger crissalis, 150, 155
Formicidae, 105-107
 Forte de France, Martinique, W. I., 296
 Four-eyed fish, 109
 Fowler, 255, 283-284
Frederickena viridis, 155
Fringillidae, 148, 171
 Frog, 46, 59, 61
 Black-faced, 46
 Froggatt, W. W., 456
 Frontal tube (termites), 300
Fulgoridae, 76
 Fuller, Claude, 298, 456
 Fungi, British Guiana, 29, 30
 Funkhouser, W. D., 231, 233, 236, 248, 252, 255, 262, 267, 271, 272, 282, 284, 285
Furipteridae, 178
Furnariidae, 148, 168
 Furniture,
 wood for, 33
 Gaige, Dr. F. M., 293, 342, 346, 350, 367, 378, 383, 385, 388, 395, 419, 449
Galbulidae, 166
Galbula albirostris, 154
 Galliformes, 146, 158-159
Gamasidae, 62
Gammarus, 59
Gampsonyx, 130, 152
 swainsoni, 152
 Gar, 109
 Garnets, red, British Guiana, 16, 17
Gasteropelecus sternicla, 118, 119
 Gasteropods, 57
Gastrophryne, 124, 125
 microps, 124, 125
 ovale, 124
 Gay, C., 456
Geckonidae, 133
 Geckos, 66, 127, 128, 129, 133
Gelastigonia hirsuta sp. nov., 256, 275, 281, 284
 (Pl. IV, fig. 2, 2a; Pl. VI, fig. 4), 254, 264
 Gentians, Shore, 25
Geometridae, 81, 82-83
Geomyzidae, 98
Geophagus, 115, 118, 120, 480
 jurupari, 118, 120
 surinamensis, 118, 120
Geophilidae, 64
 Georgetown, British Guiana, 14, 21, 193, 296
Gerridius scutellatus Fowler, 261-262
 Giant Hyla, 122
 Ginger, wild, British Guiana, 29
 Ginger Lilly, 41
 Glanencheli, 114
Globitermes, 430
Glossophaga, 178
Glyphorhynchus cuneatus, 50, 71, 143, 151, 155, 168
Glyptotermes, 297, (see also *Kaloterme*s)
 Gmelin, 195
 Gnat-catcher, 170
 Gnats, 46, 47, 50
 Gneisses, British Guiana, 16
 Goatsucker, Giant, 142, 164
 Gobies, sand, 109, 116
Gobiidae, 116
 Gold, British Guiana, 17, 192
 Goldbird, 144
Gomphidae, 73
Gonatodes, 129, 132, 133
 beebei, 133
 Gongasockas, 133
Gonium, 53
 Gordiacea, 55
Grallaria brevicauda, 155
Granatellus, 171
 Granite, British Guiana, 16
 Grant, Madison, 1
 Grasses, British Guiana, 25
 Grasshopper, 45, 46, 47, 48, 49, 50, 67-68
 Giant Green, 45
 Green Stick, 46
 Long-horned, 47
 Small Brown, 46, 49
 Tryxalid, 50
 Yellow-lined, 45, 48
 Grebe, 159, 160
 Greenheart, British Guiana, 3
 Grenada, W. I., 296
 Grison, 179
 Gromweagle, 187
 Grosbeak, 171
 Ground-beetles, 89
 Gruiformes, 146, 147, 160
Gryllidae, 68-71
Gryllides, 69-70
Gryllotalpides, 69
 Guan, Lesser Olive, 141
 Guana, 31

- Guava, Wild, British Guiana, 35, 39
Guerlinguetus aestuans, 50, 181
 Guiana British, ecology of,
 see "Studies of a Tropical Jungle"
 Guiana Bull-frog, 123
 Guiana Mahogany, 30
 Gun-stocks, 32
 wood for, British Guiana, 32
 Gymnocerata, 74-75
Gymnorhamphichthys, 116, 117, 118, 119, 120
 hypostomus, 116, 117, 118, 119, 120
Gymnotidae, 114
Gymnotus carapo, 116, 119, 120
Gyrinidae, 90
 Hacka, 175
 Hagen, H. A., 294, 359, 375, 421, 449, 454,
 457
 Haiawa, 40
 Hair worms, 55
 Haldeman, S., 457
 Halfbeak, 109
Halictus, 102
Haliplidae, 89
Hamitermes, 294, 430
 excellens, 294, 431
Haplarmadillo Dollfus, 491
Harpagus, 130, 152
 bidentatus, 152
Harpia harpyia, 152
Harpiprion, 162
 Harrison, Sir John, 16
 Hartley, Mr. Inness, 140
 Harvestmen, 50, 61
 Hassas, 110
 Hattee balli, 31
 Haviland, G. D., 457
 Haviland, Maud D. (Mrs. H. H. Brindley),
 Membracidae of Kartabo, Bartica Dis-
 trict, British Guiana, 229-290
 (Fig. 23; Plates I-VI incl.), 232,
 234, 238, 246, 254, 260, 264
 for paged outline see *Membracidae*
 of Kartabo
 Hawk, 64, 142, 163
 Black-faced, 142
Hebridae, 74
Hedychium coronarium Konig, 41
 Heer, O., 457
Helicina, 57
Heliconias, 29
Heliconiidae, 83, 87
Helicopsis, 87,
Helicops, 135
Helicopsyche, 80
Heliornis, 111, 149, 159
 fulica, 149
Heliornithidae, 159
Heliothrix aurita aurita, 142, 154
Helogenidae, 113
Hemerobiidae, 79
Hemerobius marginalis, 348
Hemiancistrus braueri, 119
Hemicetopsis macilentus, 119, 120
Hemiderma, 178
Hemidoras carinatus, 116, 117, 118, 120, 476
 Hemiptera, British Guiana, 39, 49, 51, 74-76
Hemirhamphidae, 115
Hemisorubim platyrhynchos, 120
 Hemp, sisal, British Guiana, 41
 Hermit, 142
 Cayenne, 142
 Red-vented, 142
 Heron, 112, 142, 162
 cocoli, 162
 Little Blue, 142
Herpailurus, 179
Herpetodryas, 136, 138
Herpsilochmus, 143, 155
 sticturus sticturus, 143, 155
Hesca Budde-Lund, 493
Hesperia, 88
Hesperiidae, 83, 88
 Heterocera, 81-83
 Heterognathi, 113-114
Heteronotus, 245-247, 278, 282, 283
 albospinosus sp. nov., 245, 282
 (Pl. III, fig. 6), 246
 armatus Lap., 245, 278, 282
 (Pl. III, fig. 8), 246
 vespiformes sp. nov., 247, 282,
 (Pl. III, fig. 7), 246
 Heteroptera, 75
 Heterosomata, 116
Hevea, 31
Hieronyma laxiflora Muell. Arg., 32
Hille herbicola sp. nov., 255-256, 275, 281,
 283
 (Pl. IV, figs. 1, la), 254
 Hills Plantation, British Guiana, 7
 Hindus, British Guiana, 192
Hippeastrum, 41
Hippoboscidae, 99
 Hirudinea, 57
Hirundinidae, 147, 170
Histeridae, 90
 Hoatzin, 158
 Holmgren, Nils, 297, 298, 299, 316, 337, 340,
 344, 346, 357, 363, 367, 379, 416, 430,
 432, 457
Holobrycon pesu, 118, 119, 120
Holophora pertusa, 284
 Holotype, 300
 Homoptera, 76-78
 Honey-creepers, 40
 Honey-dew of *Membracidae*, 271
 Hoobooballi, 31
 Hoomalgee, 31
 Hoorooowassa, 33
Hoplosternum thoracatum, 119
Horiola, 249, 268, 272, 273, 282
 arcuata (Fabr.) and Fowler, 249, 268,
 272, 273, 282
 ferruginea Fairm., 249, 268
 Hornets, 103-104
 Horse Tails, 25
 Hubudi, 31
Humirium floribundam Mart, 35
 Hummingbird, 40, 46, 47, 49, 51, 164
 Cayenne Hermit, 46
 Long-tailed, 51
 Rufous Hermit, 46
 Wood Nymph, 47
Hydrochaeridae, 180
Hydrochaerus, 180
Hydrocynus, 111, 121
 cuvieri, 121
Hydrolicus scomberoides, 117, 121
Hydrophilidae, 90
Hydrops, 111, 135, 136, 138, 139
Hydropsalis schomburghki, 154
 Hydrozoa, 54
Hyla, 122, 123, 124, 125
 albomarginata, 124
 boans, 125
 maxima, 123, 124
 pardalis, 124
 rubra, 122, 124
Hylidae, 121, 122
Hylomyzidae, 46, 47
Hyllopezus, 64, 149, 150, 151, 152, 155
 macularia, 149, 150, 151, 152, 155
Hymenaea combaril, Linné, 32
Hymenocallis, 41
 Hymenoptera, British Guiana, 51, 89, 99-
 107
Hypocnemis cantator, 150, 155
Hypolophus murinus, 50, 143
Hyporhamphus roberti, 117, 118, 119, 120
Hypsidae, 81, 82
Hypsoprora, 242-243, 276, 283

- aspera* sp. nov., 242-243
 (Pl. II, fig. 7), 238
insignis Buckton, 258-259
 (Pl. IV, fig. 7; Pl. V, fig. 5), 254, 260
Ibididae, 162
Ibis, 162
Ibycter, 47, 49, 142, 150, 153, 163
 americanus, 47, 142, 150, 218
 ater, 49, 153
Ichneumon-Fly, 45, 46, 47, 50, 100-101
 small black, 45
 with white antennae, 46
 with yellow, black-spotted wings, 47
Ichneumonidae, 100-101
Ichnosiphon, 27
Icica heptaphyllum Aubl., 40
Icteridae, 148, 172
Icterus, 145
 chrysocephalus (Linné), 145, 157
 xanthornus, 157
Icticyon, 178-179
Ictinia plumbea, 154, 163
Iguana, 127, 128, 129, 130, 132, 134
Iguanidae, 127-128, 133-134
Ilysia, 111, 138, 139
Ilysiidae, 135, 139
 Incubation,
 egg of variegated Tinamou, 207, 220-221
 Indians, British Guiana, 27, 28, 31, 32, 40, 41, 59, 78, 126, 187, 192, 193
 basket-making, 29
 bows, 32
 canoes, 32
 clearings, 27
 food, 31, 35, 41, 59, 110, 114, 126, 158
 paddles, 31
 parasites, 78
 Indigo, 39
Indigofera sp., 39
 Infusoria, 53
Inga sp., 31
Inia, 112, 185-186
 Insecta, British Guiana, 2, 51, 65-107, 291-459
 orders represented at Kartabo, 65
 Insectivora, 174
 Insects, British Guiana, 51, 65-107, 291-459
 Instinctive reactions,
 chick of Tinamou, 224-227
Ionornis, 159
Iphisa, 129
Iridoprocne albiventris (Bodd.), 144, 170
 Iron-ore, British Guiana, 16
Ischnocentrus niger Stal., 259, 279, 281
 Isopoda, 59, 461-503
 Isopods, The, of Kartabo, Bartica District, British Guiana, by Willard G. Van Name, 461-503
 (Plates VII-XXVI incl.), 469, 472, 474, 475, 477, 478, 479, 481, 482, 485, 487, 489, 491, 493, 494, 495, 496, 498, 500, 501
 Bibliography, 502-503
 Description of species, 469-501
 Isopods previously recorded from Guiana, 462-268
 List of species in this collection, 461-462
 Isoptera, British Guiana, 51, 71-72
 Isospondyli, 114
 Issororo River, B. G., 296
 Ithomiids, 49, 51, 84
Ixodidae, 62-63
 Jacamar, 143, 166
 Golden, 143
Jacamerops aurea, 143, 151
Jacana spinosa, 153
Jacanidae, 160
 Jaguar, 175, 179
 Jaguarondi cat, 175, 179
 Jay, 64, 173
 Jhering, H. v., 458
 Johannsen, Prof. O. A., 293
Julidae, 64
 June Bugs, 89
 Jungle, British Guiana, 27-36
 ecology, see "Studies of a Tropical Jungle" by William Beebe, 1-193
 palms, 35
 trees, 30-35
 Jungle clearings, British Guiana, 27, 37-41
 Jungle life, one hour of, 44-51
 Jungle laboratory, Kartabo, 1-22, 36, 38
 (Figs. 6, 7), 36, 38
 maps showing location, 4, 6, 18
 Kaieteur Falls, British Guiana, 6-7, 15, 296
 Kalacoon, British Guiana, 7, 41
Kaloterms, 297, 298, 301, 312-313, 316-339
 (*Cryptoterms*), 297, 301, 312-313, 326-331
 brevis (Walker), 301, 312, 326-329
 description, 326-329
 (Fig. 29), 327
 cubicoceps sp. nov., 301, 313, 330-331
 description, 330-331
 (Fig. 31), 330
 verruculosus sp. nov., 301, 313, 329-330
 description, 329-330
 (Fig. 30), 328
 (*Glyptoterms*), 297, 301, 313, 331-337
 guianensis sp. nov., 301, 313, 335
 description, 335
 (Fig. 33), 334
 hospitalis sp. nov., 301, 313, 336-337
 description, 336-337
 (Fig. 34), 337
 pellucidus sp. nov., 301, 313, 331-332
 description, 331-332
 (Fig. 31), 330
 perparvus sp. nov., 301, 313, 332-334
 description, 332-334
 (Fig. 32), 333
 (*Lobiterms*), 301, 313, 337-339
 nigriceps sp. nov., 301, 313, 337-339
 description, 337-339
 (Fig. 35), 338
 (*Neoterms*), 297, 301, 312, 316-320
 clearei sp. nov., 301, 312, 316-318
 description, 316-318
 (Fig. 34), 317
 holmgreni Banks, 301, 312, 319-320
 description, 319-320
 (Fig. 25), 319
 kartaboensis sp. nov., 301, 312, 318-319
 description, 318-319
 (Fig. 25), 319
 (*Rugiterms*), 297, 301, 312, 320-326
 bicolor sp. nov., 301, 312, 320-322
 description, 320
 (Fig. 26), 321
 flavicinctus sp. nov., 301, 312, 323
 description, 323-324
 (Fig. 27), 322
 magninotus sp. nov., 301, 312, 324-326
 description, 324-326
 (Fig. 28), 325
Kalotermitidae, 312-313, 316-339
Kalotermitinae, 312-313, 316-339
 Kaolins, British Guiana, 16, 17
 Kartabo, British Guiana, 296
 earthquakes, 17
 expeditions, 2

- fauna, 1, 2, 43-186
 amphibians, 1, 2, 121-125
 birds, 1, 2, 39, 40, 45-51, 107, 140-173, 195-227
 collections from, 1-2
 filaria, 55
 fish, 1, 51, 106, 108-121
 fossils, 192
 insects, 2, 51, 65-107, 291-459
 invertebrates, 2, 51, 52-107
 isopods, 59, 461-503
 malaria, 53, 95
 mammals, 1-2, 173-186
 Membracidae, 77, 229-290
 mosquitoes, 53, 94-95
 reptiles, 1-2, 125-139
 snakes 134-139
 termites, 2, 291-459
 tinamou, variegated, 195-227
 vertebrates, 107-186
 flora, 22-41
 geographical position, 5-7
 maps, 4, 6, 18, 196, 198
 geology, 15-17
 history, 186-193
 jungle, 27-36
 meteorology, 7-15
 motion pictures, 2
 photographs, 2
 phyla of animals, 43
 physical character, 19-22
 Kartabo, ecology of
 see "Studies of a Tropical Jungle"
 Kartabo Station, British Guiana, of the New York Zoological Society, 1
 area devoted to research, 18
 contributions from, 1
 cost, 2
 maps, 4, 6
 motion pictures, 2
 photographs, 2
 visitors and workers, 1
 Katydid, 46, 68
 Large Green, 46
 Kernel-eater, Olive, 144
 Kingbird, 144, 145
 White-throated, 144
 Kingfisher, 111, 112, 142, 146, 164
 Belted, 146, 164
 Great Gray, 142
 Little Green, 142
 Kinkajou, 179
 Kiskadee, 144, 169
 Guiana, 144
 Lesser, 144
 Small-billed, 144
 Kiskadee Tyrant Flycatcher, 45, 111
 Kite, Swallow-tailed, 142
 Koch, C. L., 468, 502
 Kokorite Palm, 35
 Kollar, V., 458
 Kurahara, 33
 Kurupung River, British Guiana, 17
 Kyk-over-al, British Guiana, 187
Kyllinga, 26
 Labba, 180
Labiotermes, see *Cornitermes*
 Laboratory, Jungle, Kartabo, 1-22, 36, 38
 (Fig. 6, 7), 36, 38
 maps, location, 4, 6, 18
 Lacertilia, 127-128, 133-134
Lachesis, 135, 138, 139
 mutus, 139
Lamproptera, 285
 capreolus, 285
 stylata, 285
Lamprospiza, 172
Lampyridae, 91
Laniidae, 148
Lanio fulvus, 157
Laniocera hypophyrrha, 156
Laporinus, 120
 alternus, 120
 nigrotaeniatus, 120
Laridae, 160
Lariformes, 146, 147, 160
Larridae, 104
Lasiocampidae, 81
Lathria cinerea cinerea (Vieill.), 144, 156, 170
 Latreille, P. A., 458
 Lau-lau catfish, 108, 113, 476, 480
 Lavarre, 346, 378
 Leach, 462
 Leeches, 57
Legatus albicollis, 156
Leioscyta, 239-240
 beebei sp. nov., 239-240
 (Pl. II, fig. 1), 238
 spiralis sp. nov., 240
 (Pl. I, fig. 5; Pl. II, fig. 2), 234, 238
Leistes militaris militaris (Linné), 145, 157, 173
Leopardus, 179
Lepidoenas speciosa, 159
 Lepidoptera, British Guiana, 51, 80-88
Leporinus, 116, 117, 118, 119, 120
 alternus, 117, 119
 arcus, 116, 118
 fasciatus, 120
 nigrotaeniatus, 116, 117, 119
Leposoma, 129, 130, 132
Leptidae, 96
Leptodactylus, 46, 53, 111, 123, 124
 caliginosus, 124, 125
 lineatus, 125
 mystacinus, 46, 124, 125
 pentadactylus, 123, 124, 125
 rhodomystax, 53, 125
 stictigularis, 124, 125
Leptognathus variegata, 58, 136
Leptophis, 135
Leptoptila, 45, 153
 rufaxilla, 45, 153
 verrauxi, 153
Leptotrichus, 462, 466, 486-488
 emarginatus Pearse, 466
 pittieri Pearse, 462, 486-488
 description, 486-488
 (Plate XVII, figs. 37-42 incl.) 487
Leptotyphlopidae, 135, 138
Leptotyphlops, 71, 135, 136
 Letterwood, 32, 44
Leucolepis, 46, 47, 144, 156, 170
 arada, 156
 musica, 46, 47, 144
Leucopternis, 64, 130, 142, 150, 152, 153, 163
 melanops, 142, 150, 152, 153
Leucotermes, 294, 297, 303, 313, 340-343
 crinitus sp. nov., 303, 313, 342-343
 description, 342-343
 (Fig. 36), 341
 tenuis, 294, 297, 303, 313, 340-342
 description, 340-342
 (Fig. 36), 341
Leucotermitinae, 313, 340-344
 Lianas, British Guiana, 23, 27, 29
Libellulidae, 73-74
 Lice, 78
 Lichens, 26, 29, 30
 Light, S. F., 298, 458
Ligia, 467-468
 baudiniana Milne-Edwards, 468
 cajennensis Koch, 468
 cayennensis Stuxberg, 468
 exotica Roux, 468
 gracilis Moore, 468
Ligyda, 462, 467, 468, 497-500
 baudiniana (Milne-Edwards), 468
 cajennensis (Koch), 468
 exotica (Roux), 467, 497-499

- platycephala* sp. nov. 462, 497-500
 description, 497-500
 (Plate XXIV, figs. 67-71 incl.), 498
richardsonae Pearse, 499
 (Plate XXV), 500
Ligydidae, 59, 462, 467-468, 497-500
Lily, 23, 39, 41
 British Guiana, 23, 39, 41
 aroid, 23
 ginger, 41
 spider, 41
 tiger, scarlet, 39, 41
Limacodidae, 81
 Lime trees, British Guiana, 39
 Limpkin, 160
 Linau, Postholder, 192
 Linnaeus, C., 458
Liophis, 136
Lipangus simplex, 156
Liparidae, 81
Livoneca, 461, 462, 468, 473-478
 guianensis sp. nov., 461, 476-478
 description, 476-478
 (Plates XI-XII, figs. 15-18), 477, 478
 redmanni Leach, 462
 sinuata, 475
 symmetrica sp. nov., 461, 473-476
 description, 473-476
 (Plate IX-X, figs. 9-14 incl.), 474-475
 Lizard, 46, 50, 64, 66, 77, 127-129
 Ameiva, 50, 128, 129
 Anolis, 64, 128, 129, (Fig. 12), 128
 breeding, 132-133
 diet, 130-132
 enemy and prey ecology, 129-130
 Oblique-Striped Jungle, 46
 tegu, 72
Lobitermes, see *Kalotermes*
 Locust (tree), British Guiana, 32
 Longicorns, 93
Lophobranchii, 115
Lophyraspis, 261-263, 271, 273, 279, 281, 285
 armata sp. nov., 262-263, 271, 273, 279, 281, 285
 (Pl. I, fig. 10; Pl. V, figs. 2, 2a, 2b) 234, 260
 fowleri nov. nom., 261-262, 279, 281
 pygmaea (Fabr.), 263, 285
 scutellatus Stal., 261-262
Loricaria, 113, 120
 cataphracta, 120
Loricariichthys, 120
 griseus, 120
 stewarti, 120
Loricariidae, 113
Lumbricidae, 57
Lurocalis semitorquatus, 151
Lutra, 112, 177, 179
 mitis, 179
 Lutz, F. E., 294, 386
Lycaenidae, 83, 88
Lycengraulis, 114, 473
 grossideus (Cuvier), 473
Lycides, 91
Lycoderes hippocampus (Fabr.), 258, 272, 278, 282, 283, 285
Lygydae, 76
Lymnocodium, 54
Lyprobius cristatus (Dollfus), 466
Mabuia, 128, 129, 133
 Macaw, 48, 49, 51, 142, 163
 Green-winged, 48, 49, 51
 Red-and-Yellow, 142
 Macousis, 192
Macrobrachium, 481, 483
 acantharum, 483
 lamarrei (Milne-Edwards), 481
Macrotermes, 298, 299
 bellicosus Smeathman, 298, 299
 Macrura, 59
 Mahogany, Guiana, 30
 Mahswas, 59
 Maibike, 40, 41
 Makreekoonee, 35
 Malacostraca, 59-60
 Malaria,
 at Kartabo, British Guiana, 53, 94-95
 Mallophaga, 72, 214
 Mammalia, 173-186
 enemies, 176-177
 Kartabo, British Guiana, 173-186
 Orders of New York State and of Kartabo, 174-175
 prey, 176-177
 Mammals, British Guiana, 47, 48, 50, 51, 173-186
 enemy and prey ecology, 176-177
 Mamoo Swagger, 195
Manacus manacus, 46, 144, 148
 Manakin, 46, 49, 144, 148
 Crackling, 46, 144, 148
 Golden-headed, 144
 White-crowned, 49, 144
 Manatee, 185
 Mangroves, British Guiana, 20, 23, 24, 31
 (Fig. 3), 24
 Manicole Palm, 35
Manikup albifrons, 155, 167
 Mann, Wm. M., 293, 414, 458
Mantidae, 66
 Mantis, Green, 48
Mantispidae, 79-80
 Marabuntas, 103-104
Marcgravia, 26, 40-41
Margay, 176, 177, 179
 Margay cat, 176, 177, 179
 Marine Toad, 122
Marmosa, 177
 Marmosets, 183
 Marsupialia, 174, 176, 177-178
 Martin, 144, 146, 170
 Gray-breasted, 144
 Guiana, 170
 Purple, 144
 Martinez, 186
 Martinique, W. I., 296
 Mastigophora, 53
 Mata-mata, 127
 Matchwood Tree, British Guiana, 32
Mauritia flexuosa L. f., 35
Maximilliana regia Mart, 35
 Mayflies, 73
 Mazaruni River, British Guiana, 1, 5, 7, 19, 20, 22, 187, 296
 McIndoo, N. E., 293, 458
Mecistogaster, 49, 74
Meconemides, 68
Mecopodites, 68
 Mecoptera, 80
 Medusa, fresh-water, 54
 Meerah-wood, 33
Megaceryle, 142, 164
 torquata cyanea, 142
Megachile, 103
Megachilidae, 103
Megalodoras, 117
Megalopygidae, 81
Megarhynchus pitangua (Linné), 144, 156
 Meinert, F., 462, 475, 478, 480, 481, 503
Melalophidae, 81
Melanerpes rubrifrons, 154
Melanopsar chrysocephalus, 157, 173
Melastomas, 39
Melinaea, 46
 mneme Linn., 86
 (Fig. 10), 86
Melipona, 101
Meliponidae, 101-102

- Melitoma*, 103
Membracidae of Kartabo, Bartica District, British Guiana
 With Descriptions of New Species and Bionomical Notes, by Maud D. Haviland (Mrs. H. H. Brindley) 229-290
 (Fig. 23; Plates I-VI incl.), 232, 234, 238, 246, 254, 260, 264
 acknowledgements, 229-231, 273
 attendance by ants, 271-273, 279-282
 enemies, 273-274
 field observations, 274-282
 geographical distribution, 265-267
 introduction, 229-231
 key to species, 286-290
 life-histories and habits, 267-271
 list of species, 231-265
 nymphal forms, 282-285
Membracidae, British Guiana, 39, 45, 46, 48, 49, 77, 229-290
Membracis, 231-232, 268, 273, 274, 275, 282, 283, 284
arcuata (Oliv.) and Fairm., 231, 282
bicristata Fairm., 237
c-album Fairm., 231, 268, 275, 282, 284 (Pl. VI, fig. 9), 264
carinata (Fabr.), 231
fasciata (Fabr.) and Fairm., 233, 274
fusca De Geer and Fairm., 233, 268, 282
humilis Fowler, 233
tectigera (Oliv.) and Fairm., 233, 273, 275, 282 (Fig. 23, b), 232
Mesarmadillo americanus Dollfus, 467, 484-486
 description, 484-486
 (Plate XVI, figs. 27-36 incl.), 485
Mesophylla, 178
Mesopra, 39, 40
Metachirus, 177
Metals, British Guiana, 16, 17
Metoponorthus pruinosus Budde-Lund, 465
Mica, British Guiana, 16
Mice, 176, 177, 181
 house, 181
Micrastur, 152, 153
gilvicollis, 153
interestes, 152
Microcerulus bambla, 156
Microcerotermes, 297, 298, 304, 315, 375, 453-455
arboreus sp. nov., 304, 315, 453-455
 description, 453-455
 (Fig. 94), 454
Microcyprini, 115
Microlepidoptera, 81
Microphila, 157
castaneiventris, 157
minuta, 157
Micropodidae, 164
Micropterygidae, 81
Microstigmus, 66
Micrurus, 111, 135, 136, 138, 139
marcgravi, 138
Miers, E. J., 465, 466, 467, 491, 493, 502
Mikania orinocensis H. B. K., 39
Miller, Mr. de W., 168
Millipede, 50, 51, 63-64
Milne Edwards, A., 465, 466, 468, 481, 502
Milvago chimachima, 153
Mimicry (insects), 274-282
Mimidae, 147, 170
Mimosa polydactyla H. & B. 39
Mimus, 170
Minerals, British Guiana, 16, 17
Minnow, Land, 46
Mirotermes, 297, 304, 315, 432-445
 (*Cavitermes*) subg. nov., 304, 315, 442-444
tuberosus sp. nov., 304, 315, 442-444
 description, 442-443
 (Fig. 88), 443
 (*Crepititermes*) subg. nov., 304, 315, 433-435
verruculosus sp. nov., 304, 315, 433
 description, 433-435
 (Fig. 84), 433
 (*Mirotermes*), 304, 315, 435-442
acutinasus sp. nov., 304, 315, 439-440
 description, 439-440
 (Fig. 86), 438
hispaniolae Banks, 304, 315, 437-439
 description, 437-439
 (Fig. 85), 435
inquilinus sp. nov., 304, 315, 440-442
 description, 440-442
 (Fig. 87), 441
nigritus (Silvestri), 304, 315, 435
 description, 435-437
 (Fig. 85), 435
saltans, 435
 (*Spinitermes*), 304, 315, 444-445
trispinosus (Bates), 304, 315, 444-445
 description, 444-445
 (Fig. 89), 444
Mites, 62-63, 200, 214
Thrombidium, 200, 214
Mjöberg, E., 430, 458
Mniotiltidae, 147, 148, 171
Moenkhausia grandisquamis, 119
Majos, Bolivia, 296
Mole-crickets, 69
Mollusca, Kartabo, British Guiana, 43, 57-58
Molluscoida, Kartabo, British Guiana, 43, 56
Molossidae, 178
Molossus, 61, 177, 178
Molothrus, 173
Momotidae, 164
Momotus momota, 46, 142, 154
Monasa niger, 154, 166
Monkey, 47, 48, 50, 51, 173, 175, 176, 177, 183
 Beesa, 175, 183
 Cebus, 175, 177
 Red Howling, 47, 48, 50, 51, 173, 175, 183
 Ring-tailed, 51, 183
 Saki, 183
 Spider, 183
 Squirrel, 183
Monodelphis, 177
Monodontermes, 430
Monserrat, W. I., 296
Montrichardia arborens (Linné) Scott, 23
Moras, British Guiana, 26, 27, 30
 (Fig. 5), 34
Mordellidae, 92
Morphidae, 83, 85-86
Morphnus, 163
Morpho, 46, 86
hecuba, 86
menelaus, 46, 86
Morphotype, 300
Morrison, Harold, 293, 458
Mosquitoes,
 at Kartabo, British Guiana, 53, 94-95
Mosses, British Guiana, 26, 29, 30
Motacillidae, 147, 171
Moths, 49, 50, 80-88
Motmots, Guiana, 46, 49, 142, 164
Motschulsky, von, 458
Mottram, 275
Moult,
 of variegated Tinnamou, 210
Mouse, 191

- house, 181
 spiny, 181
Mucka-mucka, British Guiana, 23
 Müller, Fritz, 298, 458
Muridae, 181
Mus, 181
Muscicapidae, 147, 170
Muscidae, 98
Muscivora tyrannus, 151, 156, 169
 Muscovite, British Guiana, 16, 17
 Muscovy duck, 162
Mustelidae, 179
Mutillidae, 104
Mycetophilidae, 94
Mycteria, 112, 162
Mydidae, 96
Myiarchus ferox, 149, 152, 156
Myiobius barbatus barbatus, 144, 156
Myiodynastes maculatus, 151
Myiozetetes cayennensis cayennensis, 144, 156
Myleus pacu, 120
Myloplus, 119
 rhomboidalis, 120
 rubripennis, 119, 120, 476
Myobius, 169
Myoprocta, 180
 Myriapoda, 63-64
Myristica surinamensis Roland, 33
Myrmecophaga, 71, 182
Myrmecophagide, 182-183
Myrmecophilides, 68
Myrmeleonidae, 79
Myrmoborus, 143, 150, 155
 leucophrys angustirostris, 143, 150, 155
Myrmoderus ferrugineus, 47, 150, 151, 155
Myrmopagis, 143, 150, 155
 axillaris axillaris, 143, 150, 155
 cinereiventris cinereiventris, 143
Myrmornis torquata, 155
Myrmotherula pygmaea, 48, 143
Nasiaeschua, 73
Nasua, 64, 130, 177, 179
Nasutitermes, 294, 297, 298, 299, 303, 304, 314, 375-420
 (*Angularitermes*), 304, 314, 419-420
 nasutissimus sp. nov., 304, 314, 419
 description, 419-420
 (Fig. 75), 418
 (*Constrictitermes*), 304, 314, 416-419
 carifrons (Holmgren), 304, 314, 417-419
 description, 417-419
 (Fig. 74), 417
 (*Convexitermes*), 303-304, 314, 407-414
 kartaboensis sp. nov., 304, 314
 description, 409-410
 (Fig. 70), 409
 manni sp. nov., 304, 314, 412-414
 description, 412-414
 (Fig. 72), 413
 mazaruniensis sp. nov., 304, 314, 411
 description, 411-412
 (Fig. 71), 411
 nigricornis (Holmgren), 303, 314, 407
 description, 407-409
 (Fig. 69), 408
 holmgreni, 294, 299, 392
 (*Nasutitermes*), 303, 314, 376-397
 acajutlae (Holmgren), 303, 314, 387-388
 description, 387-388
 (Fig. 58), 387
 banksi nom. nov., 294, 299, 303, 314, 392
 description, 392-393
 (Fig. 61), 392
 brevipilus sp. nov., 303, 314, 395-397
 description, 395-397
 (Fig. 63), 396
 comstockae sp. nov., 303, 314, 390
 description, 390
 (Fig. 57), 396
 costalis (Holmgren), 303, 314, 379-381
 description, 379-381
 (Fig. 55), 380
 ephratae (Holmgren) 294, 303, 314, 381-383
 description, 381-383
 (Fig. 55), 380
 gaigei sp. nov., 303, 314, 394-395
 description, 394-395
 (Fig. 62), 395
 guayanae (Holmgren), 294, 303, 314, 376
 description, 376-378
 (Fig. 54), 377
 intermedius Banks, 303, 314, 388
 description, 388-390
 (Fig. 59), 389
 octopilis Banks, 294, 303, 314, 383-385
 description, 383-385
 (Fig. 56), 384
 surinamensis (Holmgren), 303, 314, 395
 description, 385-386
 (Fig. 57), 386
 wheeleri sp. nov., 303, 314, 391-392
 description, 391-392
 (Fig. 60), 391
 (*Subulitermes*), 303, 314, 397-407
 baileyi sp. nov., 303, 314
 description, 398-399
 (Fig. 64), 397
 oculatissimus sp. nov., 303, 314, 400
 description, 400-402
 (Fig. 65), 401
 osborni sp. nov., 303, 314, 404-405
 description, 404-405
 (Fig. 67), 404
 parvulus (Silvestri), 294, 303, 314, 399
 description, 399-400
 (Fig. 64), 397
 raripilus sp. nov., 303, 314, 402-403
 description, 402-403
 (Fig. 66), 403
 snyderi sp. nov., 303, 314, 405-407
 description, 405-407
 (Fig. 68), 406
 thompsonae, 299, 398
 (*Velocitermes*), 304, 314, 414-416
 beebei sp. nov., 304, 314
 description, 415-416
 (Fig. 73), 414
Neacomys, 181
Nectandra rodiei Schomb, 30
Nectandra sp., 33
Nectomys, 181
 Needlefish, 109
 Negro slaves, British Guiana, 187-188, 190
 Nemathelminthes, Kartabo, British Guiana, 43, 55-56
 Nematoda, 55, 214
 Nematognathi, 112
 Nemertea, 55
Neocapritermes, see *Capritermes*
Neomorphus rufipennis, 154, 165
Neoponera, 71, 107
 commutata Roger, 71
Neotermes, 297, (see *Kalotermes*)
Nessaea, 87
 Neuroptera, 79-80
Neusticurus, 129, 134
 Nibie, British Guiana, 187
Nicoletia, 65

- Nicoria punctularia*, 126
 Nighthawk, 45, 142
 Dusky, 45
 White-necked, 142
Noctuidae, 81, 82
Notharcus tectus, 151
Notodontidae, 81
Notonectidae, 74
Notophilidae, 64
Nototanais, 461, 468, 469-470
 australis Richardson, 468
 beebei sp. nov., 461, 468, 469-470
 description, 469-470
 (Plate VII, figs. 1-2), 469
 dimorphus (Beddard), 468, 470
 Nova Zeelandia, 186
 Nurse fish, 110
Nycteribiidae, 99
Nyctibius, 142, 154, 164
 griseus griseus (Gmel.), 142, 154, 164
Nyctidromus, 142, 148, 154, 164
 albicollis albicollis (Gmel.), 142, 148, 154, 164
Nymphal Membracidae, 282-285
Nymphalidae, 83, 87
Nyssonidae, 105
Obisiidae, 61
Obisium, 61
 Ocelot, 175, 177, 179
Octodontidae, 181
 Odonata, British Guiana, 51, 73-74
 Odontoceti, 185-186
Odontophoridae, 159
Odontophorus, 141, 153
 guianensis guianensis, 141, 153
Odontotermes, 298
Oecanthides, 70
Oecomys, 181
Oenaenas purpureotincta, 141
Oestridae, 99
 Oko Mountains, British Guiana, 19
 Oligochaeta, 56
 Omai, British Guiana, 17
 Onderneeming, B. G., 296
Oniscidae, 59, 461, 462, 462-467, 484-497
 500-501
Oniscinae, 462, 486-497
Oniscoidea, 461-462, 462-468, 484-501
Onychophora, 63
Orycorhynchus coronatus coronatus, 144, 169
Opalina, 153
Ophryoesa, 128, 129, 130, 131, 132, 133, 134
Opossum, 176, 177
Oreopelia montana, 153
 Orinoca River, 186, 187
 Oriole, 45, 145, 172-173
 Giant Black, 45, 172
 Morange, 145
Ornithion pusillum, 156
 Orri-orri, 195
Ortalidae, 98
Ortalis motmot (Linné), 141, 153, 159
Orthalicus sultana, 57
Orthognathotermes, 297, 304, 315, 451-453
 macrocephalus (Holmgren), 304, 315, 451-453
 description, 451-453
 (Fig. 93), 451
 Orthoptera, British Guiana, 45, 46, 47, 48, 49, 50, 51, 66-71
Orthotermes, 432
Oryzoborus brevirostris, 157, 171
Oryzomys, 181
 Osborn, Henry Fairfield, 1-2, 405
 Introduction to Beebe's "Studies of a Tropical Jungle," 1-2
Ostinops, 45, 145, 157, 172-173
 decumanus decumanus (Pall.), 145, 157
Ostracoda, 58
 Ovenbird, 48, 50, 168
 Owl, 135, 163
Oxybelis, 45, 130, 135, 136, 139
 Paca, 180
Pachira aquatica Aubl., 40
Pachysylvia muscicapina muscicapina, 144, 157, 171
 Paddlewood, 30
Palaemon amazonicus Heller, 59
Palaemonetes vulgaris (Say), 483
 Palm, British Guiana, 27, 35
 (Fig. 4), 28
 cocoanut, 35
 cuyuru, 35
 eta, 35
 kokorite, 35
 manicole, 35
Panchloridae, 47
Pandion, 112, 163
Panicum, 25
Panorpidae, 80
Panthera, 179
Panyptila, 164
Papilio, 46, 51, 83-84
Papilionidae, 83-84
Paracubaris spinosus Collinge, 466, 491
Paramoecium,
 in bromeliads, 53
 Parasitica, 78
Paratanais dimorphus Beddard, 468
Paridae, 148
 Parrakeets, 72, 148, 163
 Parrot, 48, 49, 50, 142, 163
 Dusky, 49, 142
 Mealy Amazon, 48, 50, 142
 Purple Guiana, 142
 Partridge, Guiana, 141
Passalidae, 89
 Passeriformes, 147, 166-173
Paulicea, 111, 120
 lutkeni, 120
 Pearse, A. S., 465, 466, 467, 482, 484, 486, 488, 490, 494, 502, 503
Pecaritajacu macrocephalus, 185
 Peccary, 175, 185
 collared, 175, 185
 white-lipped, 185
Pediculidae, 78
 Pedipalpi, 61
 Pegmatite, British Guiana, 16
Peleciniidae, 101
 Pelicaniformes, 146, 162
Pelomedusidae, 127
 Penal Settlement, British Guiana, 7, 192, 296
Penelope, 141, 153, 159
 granti, 153
 marail, 141, 153
Pentaclethra macroloba (Willd.) Kuntze, 30
Pentatomidae, 75
Pentoniscus exilis sp. nov., 462, 500-501
 description, 500-501
 (Plate XXVI, figs. 73-77 incl.), 501
 Perai, 109, 114, 476
 Percomorphi, 115
Pericaprithermes, 445
Periopidae, 81
Peripatus, 63
 (Fig. 9), 64
Periplaneta, 66
Periporphyrus, 171
Perissodactyla, 174, 185
Perissotriccus, 156
 ecaudatus miserabilis, 156
Perla nasuta, 348
 Perty, M., 458
 Petrea, 40
 Petrel, 158
Phaethornis, 46, 51, 142, 154
 ruber, 46, 142, 154
 supercilius, 46, 142, 154
Phaetusa, 111, 142, 152, 153, 159

- chloropoda* (Vieill.), 142, 152, 153
Phalacrocoracidae, 162
Phalacrocorax, 112
Phalacrocorax nigrea, 152
Phalangida, 51, 61
Phasmid, 50, 267
Phasmidae, 66–67
Pheidole fallax Mayr., 273
Pheugopedius griseigula, 156
Philanthidae, 105
Philoscia, 59, 462, 465, 491–497
 demerare sp. nov., 462, 496–497
 description, 496–497
 (Plate XXIII, figs. 64–66 incl.), 496
 maculata Budde-Lund, 462, 494–496
 description, 494–496
 (Plates XXI–XXII, figs. 60–63 incl.), 494, 495
 nitida (Miers), 462, 465, 491–494
 description, 491–494
 (Plates XIX–XX, figs. 52–59 incl.), 491, 493
 olfersii Brandt, 465
 spinosa Say, 462–465
Philougria nitida Miers, 491–494
 description, 491–494
 (Plates XIX–XX, figs. 52–59 incl.), 491, 493
Philydor, 143, 168
 erythrocerus erythrocerus, 143
Phoenicocercus carnifex, 156
Phoenicopteridae, 162
Phoenicopteriformes, 147, 162
Phoridae, 97
Phrynonax, 136
Phyllobates inguinalis, 123, 124, 125
Phyllomedusa bicolor, 125
Phyllopoda, 58
Phyllostomus, 178
Phyllostomidae, 178
Phymatidae, 75, 76
Piaya cayana, 154, 165
Picidae, 166
Piciformes, 147, 166
Piculet, Undulated, 143
Picumnus, 45, 143, 150, 154, 166
 buffoni undulatus, 45, 143, 150, 154
Pieridae, 48, 50, 83, 84
Pig, wild, 176
Pigeon, 45, 47, 141, 159
 Jungle, 45, 47
 Purple-tinted, 141
Pigeon-berry, 31
Pillbugs, 59
Pimelodella cristata, 118, 120
Pimelodus, 56, 59, 113, 116, 117, 118, 119, 470, 480
 clarias, 116, 117, 118, 119, 470, 480
 ornatus, 117, 118
Pinwheel flower, 39
Pionites melanocephala, 142, 154
Pionus, 49, 142, 154
 fuscus, 49, 142, 154
 menstruus, 154
Pipa, 122
 americana, 122
 aspera, 122
Pipefish, 109, 115
Pipidae, 121, 122
Pipit, 171
Pipra, 49, 144, 156,
 aureola, 156
 erythrocephala erythrocephala, 144, 156
 leucocilla leucocilla, 49, 144, 156
 suavissima, 156
Pipramorpha, 144, 151, 156
 oleaginea, 144, 151, 156
 macconnelli, 156
 oleaginea, 144, 156
Pipridae, 148, 169
Piprites chlorion, 156
Pipunculidae, 97
Piratinera guianensis Aubl., 32
Pisces, Kartabo, British Guiana, 51, 106, 108–121
Piscivorous vertebrates, 111
Pitangus, 45, 112, 144, 149, 151, 152, 156, 169
 lictor licitor (Licht.), 144, 151, 156
 sulphuratus sulphuratus (Linné), 144, 156
 sulphureus, 149, 152
Pithecia, 183
Pithecolobium latifolium Benth., 41
Pithys albifrons, 50, 143, 149
Pitylus, 144, 157, 171
 canadensis canadensis, 144
 grossus, 157
Placostomus gumia, 151, 155
 griseiceps, 155
 gumia, 151
 saturatus, 155
Plagioscion, 111, 115, 117, 118, 121
 auratus, 117, 118, 121
Planesticus, 144, 156, 157
 albiventer, 157
 fredericki, 156
 fumigatus, 144
 phaeopygus, 157
Plasmodium, 53
Platanistidae, 185–186
Platemys platycephala, 127
Platyhelminthes, Kartabo, British Guiana, 43, 54–55
Plecoptera, 72
Plecostomus, 113, 119
 plecostomus, 119
Plectognathi, 116
Pleuronectidae, 116
Plica, 64, 128, 129, 130, 131, 134
Plover, 142, 145, 146, 159
 Collared, 142
 Golden, 145
 Semipalmated, 145
 Upland, 146
Plum,
 hog, 31
 wild, 31
Plumatella, 56
Plume-grass, 39
Podicipidae, 160
Podicipidiformes, 146, 147, 160
Podocnemis, 127
 expansa, 127
 unifilis, 127
Poduridae, 65–66
Poecilidae, 115
Poecilurichthys abramcoides, 116, 117, 119, 120
Poliolaema, 155
 cinereiventris, 155
 guttata, 155
Polybia, 71
Polycentridae, 116
Polychaeta, 56
Polychrus, 128, 129, 130, 131, 132, 133
Polydesmid, 50, 64
Polyglytodes flavocostatus sp. nov., 255
 (Pl. IV, fig. 3, 3a), 254
Polytmus chrysobranchus, 154
Pomeroon River, 186
Pompilid, 45
Pompilidae, 104
Porcellio, 59, 465, 466
 brunneus Brandt, 465
 cristatus Dollfus, 466
 cayennensis Miers, 466
 jelskii Miers, 465
 flavovittatus Miers, 465
Porcellionides, 465
 brunneus (Brandt), 465
 jelskii (Miers), 465

- pruinus* (Brandt), 465
 Porcupine, 176, 177, 180
 Tree, 180
 Porifera, Kartabo, British Guiana, 43, 53-54
 Port of Spain, Trinidad, 296
Porzana albicollis, 153, 159
Posequeria latifolia R. & S., 40
Potamotrygon, 111, 116, 117, 118, 119, 120
 hystrix, 116, 117, 118, 119, 120
 Potaro Landing, B. G., 296
 Potaro River, B. G., 296
 Potchuwee, 33
Potos, 179
 Poulton, Prof., 267, 274, 277, 279, 280
 Primates, 174, 183-185
 British Guiana, 183-185
 Primroses, Mazaruni, 25, 37, 81
Prionodactylus, 129
Pristella riddlei, 116, 119
Pristidae, 112
Probopyrus, 59, 461, 468, 481-484
 bithynis Richardson, 461, 481-484
 description, 481-484
 (Plates XIV-XV, figs. 24-26, incl.)
 481-484
 floridensis Richardson, 483
 panamensis Richardson, 483
 pandalicola (Packard), 483
 Procellariiformes, 147
Prochilodus rubrotaeniatus, 120
Proctotrypidae, 100
Procubitermes, 432
Procyon, 179
Procyonidae, 179
Proechimys, 130, 181
Progne chalybea chalybea, 144, 151, 156, 170
Promirotermes, 433
Protrhinotermes, 297, 298, 344
 Prosobranchs, 57
Protermitidae, 316-339
Protocapritermes, 432
 Protozoa, British Guiana, Kartabo, 43, 52-53
Pselaphidae, 90
Pseudis, 123
Pseudoagelaus, 173
Pseudoscorpionida, 61
Psidium guava, 35, 39
Psilidae, 98
Psilopornis albirostris, 166
Psittacidae, 163
Psittaciformes, 147, 163
Psocids, 72
Psophia crepitans, 153, 160, 161
 (Fig. 14), 161
Psophidae, 160-161
Psychodidae, 95
Psyllidae, 78
Pteroglossus, 142, 154
 aracari, 154
 viridis, 142, 154
Pteronura, 179
Pterygia uropygii Buckt., 242, 276
Ptinidae, 91
 Puffbird, 143
 Collared, 143
 Swallow, 143
 Puffers, 109, 116
Pulicidae, 99
 Pulmonates, 57
Pulsatrix, 135, 152, 163
 perspicillata, 152
 Puma, 179
 Pumpwood, 33
 Purpleheart, British Guiana, 26, 27, 32
 Puruni Trail, 40, 44
Pycnoscelus, 66
Pygidiidae, 113
Pygidium guianensis, 118
Pyralidae, 81, 83
Pyrrhocoridae, 75, 76
 Quadrille Bird, 46, 47, 144, 148, 170
 Quartz, British Guiana, 16
Querula purpurata, 156
 Raccoon, 179
 crab-eating, 179
 Rain forest, British Guiana, 27-36
 Raleigh, Sir Walter, 186
Rallidae, 159
Ralliformes, 146, 159
 Rambur, P., 458
Ramphastidae, 166
Ramphastos, 46, 142, 154, 166
 monilis, 154
 vitellinus, 46, 142, 154, 166
Ramphocelus, 45, 145, 157, 172
 carbo carbo (Pall.), 145, 157
Ranidae, 121, 123
 Rat, 176, 177, 181
 house, 181
 jungle, 181
 spiny, 176, 177, 181
 water, 181
Rattus, 181
 Rays, 109, 112
 sawfish, 112
 sting, 109, 112
 Redstart, 146
Reduviidae, 75, 76
Reinarda, 164
 Reptilia, 51, 125-139
 Reptiles, British Guiana, 51, 125-139
 Retzius, A. I., 459
Rhamdia sebae, 118
Rhamphocaetidae, 148
Rhamphocaenidae, 168
Rhamphocaenus albiventris, 48, 143, 155, 168
Rhexia kartabensis sp. nov., 244
 (Pl. II, fig. 8), 238
Rhinotermes, 294, 297, 303, 313, 346-357
 (*Rhinotermes*), 347-357
 hispidus sp. nov., 303, 313, 350-351
 description, 350-351
 (Fig. 40), 351
 longilabius sp. nov., 303, 313, 352-354
 description, 352-353
 (Fig. 41), 353
 marginalis (Linn.), 294, 303, 313, 348-350
 description, 348-350
 (Fig. 39), 348
 nasutus (Perty), 303, 313, 347-348
 description, 347-348
 (Fig. 38), 346
 subfusciceps sp. nov., 303, 313, 356-357
 description, 356-357
 (Fig. 43), 357
 tenebrosus sp. nov., 303, 313, 354-355
 description, 354-355
 (Fig. 42), 355
Rhinotermitidae, 313, 340-357
Rhinotermitinae, 313, 346-357
Rhipiphoridae, 92
Rhipipteryx, 50, 69
Rhizophora mangle Linné, 23, 31
 (Fig. 3), 24
Rhopalocera, 83-88
Rhopias guttata (Vieill.), 143
Rhopoterpe torquata torquata, 143
Rhynchiscus, 178
Rhynchocyclus, 144, 156
 poliocephalus inquistor, 156
 sulphureus exanimatus, 144, 156
Rhynchops, 111
Rhyncophidae, 88
Rhyphidae, 96
 Rice-grackle, 145

- Richardson, H., 462, 465, 466, 467, 468, 471, 481, 482, 483, 484, 503
 Ridgway, 21, 195
 Color Standards and Nomenclature, 21-22, 209
Riodinidae, 83, 87
Rivulus stagnatus, 46, 115, 118, 119, 120
 Roach, Wood, 46, 47, 48, 50, 66
 Rodentia, 174, 175, 176, 180-183
 enemy and prey ecology, 177
 Rodents, British Guiana, 173, 174, 175, 176, 180-183
 Rodway, Mr. James, 192
 Rol, Hendrik, 189
 Roosevelt, Theodore, 1
 Roraima, plateau of, 5, 7, 15
 Rosen, von, Kurt, 392, 459
 Rotifera, 56
 Rove beetles, 90
 Rubber, British Guiana, 31, 41
Rugitermes, 297, (see also *Kaloterms*)
Rupornis magnirostris, 152
 Rupunnuni River, British Guiana, 14
 Sabrewing, Broad-shafted, 142
Saccopteryx, 178
Saimiri, 177, 183
 cassaquiarensis, 183
 St. Croix, W. I., 296
 St. Jose de Marabitanas, Brazil, 296
 St. Joseph, Trinidad, 296
 St. Kitts, W. I., 296
 St. Lucia, W. I., 296
 St. Thomas, W. I., 296
 Salempenta, 134
 Sanchez, Dominican Rep., 296
 Sandpiper, 142, 146, 160
 Solitary, 146
 Spotted, 142, 146
 Sands, British Guiana, 16
 Santarem, Brazil, 296
 Santiago, Dominican Rep., 296
Sapium jenmani Hemsl. 31
Sapromyzidae, 98
Sapygidae, 104
 Sarcodina, 52-53
Sarcophagidae, 98
Saturniidae, 81, 82
Satyridae, 83, 85
 Sawfish rays, 112
Saxicava, 58
 Scansores, 147, 165-166
Scapanus rubricollis (Bodd.), 143
Scarabaeidae, 89
 Schioedte, J. C., 462, 475, 478, 480, 481, 503
 Schomburgk, Richard, 189, 192
Sciaenidae, 115
Scincidae, 134
 Scinks, 134
Sciomyzidae, 98
Sciuridae, 181
Sciurillus, 181
Sclateria, 47, 62, 149, 150, 155
 leucostigma, 47, 155
 naevia, 62, 149, 150, 155
Sclerurus caudacutus, 155, 168
Scoliidae, 104
Scolopendra, 64
 Scorpion flies, 80
 Scorpionida, 60-61
Scotothorus olivaceus, 151, 156
 Scott, Dr. Hugh, 231
 Screamer, horned, 158
 Sedge, British Guiana, 23
 Starry, 23
 White-plumed, 23
 Sedimentary Rock, British Guiana, 16
 Seed-eater, Chestnut-breasted, 45, 144
 Sensitive plants, British Guiana, 39
 Serpentes, 134-139
Serrasalmo, 111, 121, 476
 rhombeus, 121, 476
Serritermes, 297
 Sex-ratio of Tinamous, 202
 Sharp, 100
 Sherman, H. B., 381
Shizonotidae, 61
 Shoemaker, Mr. C. R., 500
 Shooting Star blossoms, 40
 Shrimp, 59, 481-483
Sida cordifolia Linné, 37
Sigmodontidae, 181
Siluridae, 113
Silvanidae, 90
 Silverhalli, 33
 Silvestri, F., 293, 294, 297, 298, 344, 346
 421, 423, 430, 449, 459
Simarupa amara, or *officinalis*, 32
Simuliidae, 95
 Siniri, 32
Sipanea pratensis Aubl., 25, 37, 81
Siphonops annulatus, 121
 Siphonoptera, 99
 Sirenia, 174, 185
 Sisal hemp, British Guiana, 41
Sittidae, 148
 Skimmer, 160
 Skipper butterfly, 88
 Sjöstedt, Yngve, 459
 Slater, 275
 Slavery, British Guiana, 187-188, 190, 191
 Sloth, three-toed, 33, 177, 181, 182
 enemies, 177
 (Fig. 16), 182
 food of, 33
 Sloth, two-toed, 182
 Slugs, 57-58
 Small Maam, 195
 Snails, 57-58
 Snakes, 45, 134-139
 British Guiana, 134-139
 Snakebird, 111
 Snakewood, 32
 Snipe, 146, 160
 Wilson's, 146
 Snyder, Dr. T. E., 293, 298, 340, 342, 359, 407, 459
Soleidae, 116
 Sörensen, W., 459
Souroubea guianensis Aubl., 26, 40
 Sowbugs, 59
Spachea elegans A. Juss, 31
 Spars,
 British Guiana wood for, 33
Speculitermes see *Anoplotermes*
Spermacoce
 caerulescens Aubl., 37
 verticillata Linné, 37
Sphaerodactylus, 129, 130, 132, 133
Sphaeroniscus portoricensis Richardson, 466, 490
Sphegidae, 104
 Sphene, British Guiana, 16
Sphingidae, 81
Sphongophorus guerini Fairm., 242, 276, 281, 282, 283
 Spider, 46, 47, 48, 49, 51, 62
 Ctenid, 49
 Green, 46, 47, 49
 Grey Jumping, 48
 Large Brown, 47
 Metallic Jumping, 47, 49
 Red-Spotted, 47
 White Flower-like, 49
 Spider Lily, 41
 Spinel, British Guiana, 17
 Spinetail, Guiana, 143
Spinitermes, 297, see also *Mirotermes*
Spizaetus tyrannus, 152, 163
Spondias lutea Linné, 31
 Sponges,

- fresh-water, British Guiana, 53-54
Spongillidae, British Guiana, 53-54
Sporobolus, 26
Sporophila, 45, 144, 157, 171
 bouvronides, 157
 castaneiventris Cab., 144
 gutturialis roraimae, 157
 lineola, 157
Sporozoa, 53
Squirrel, 50, 181
 dwarf, 181
 Guiana, 50
Stachytarpheta cayennensis Vahl, 37
Staphylinidae, 88, 90
Starry-Sedge, 23
Stegaspis, 258-259, 260, 272, 276, 278, 281, 282, 283
 galeata Walker, 258-259, 272, 278, 281
 (Pl. IV, fig. 7; Pl. V, fig. 5), 254, 260
 insignis Funk., 258
 laevipennis (Fairm.), 258, 272, 276, 282
Stentor, 53
Stephanidae, 101
Sterna, 111, 152
 superciliosa, 152
Sterno hirundo (Linné), 142
Sternopygus macrurus, 117, 118, 119
Stictocephala indeterminata, 276, 277
Stictomyrmornis naevius, 155
Stictopelta indeterminata (Walk.), 243
Stilt, Black-necked, 145, 160
Sting rays, 109, 112
Stolephorus, 114, 117, 118, 119
 surinamensis, 117, 118, 119
Stratiomyidae, 96
Streblidae, 99
Strepsiptera, 94
Strigidae, 163
Strigiformes, 147, 163
Studies of a Tropical Jungle; One Quarter of a Square Mile of Jungle at Kartabo, British Guiana, by William Beebe, 1-193
Introduction by H. F. Osborn, 1-2
(Plates A, B, Figs. 1-17 incl.), 4, 6, 8, 18, 24, 28, 34, 36, 38, 42, 64, 86, 106, 128, 137, 161, 172, 182, 184
I. Geographical Position, 4-7
 1. Latitude and Longitude, 5
 2. Country, Rivers, 5-7
II. Meteorology, 7-15
 1. Seasons, 9
 2. Rainfall, 8-10
 3. Humidity, 10-11
 4. Sunshine, 11
 5. Temperature, 12
 6. Wind, 13
 7. Comparison with Coast and Interior, 14-15
III. Geology, 15-17
 1. Rocks, Minerals and Soil, 15-17
 2. Earthquakes, 17
IV. Physical Character, 19-22
 1. Land: altitude, levels, swamps, 19
 2. Tidal area and shore, 19-21
 3. Water: creeks, rivers, tides, 21-22
V. Flora, 22-41
 1. Aquatic, 23
 2. Littoral, 23-27
 3. Jungle, 27-36
 4. Clearing, 37-41
VI. Fauna, 42-186
 1. Protozoa, 52-53
 2. Porifera, 53-54
 3. Coelenterata, 54
 4. Platyhelminthes, 55-56
 5. Nematelminthes, 55-56
 6. Trochelminthes, 56
 7. Molluscoida, 56
 8. (Echinodermata)
 9. Annulata, 56-57
 10. Mollusca, 57-58
 11. Arthropoda, 58-107
 12. Chordata, 107-186
VII. Historical, 186-193
Stuxberg, A., 465, 466, 468, 503
Stylopidae, 94
Subulitermes, 297, see also *Nasutitermes*
Sugar, British Guiana, 44
Sun-bee, 91-92
Suradanni, 32
Surface minnow, 53
Surinam Toad, 122
Swallow, 144, 145, 170
 bank, 145
 barn, 145
 variegated, 144, 170
 White-banded, 144
Swallow-tail butterfly, 84
Swift, 45, 47, 49, 142, 164
 Palm, 164
 Short-tailed, 47
 Spine-tailed, 45
Symbranchi, 114
Symbranchidae, 114
Symbranchus, 111, 117, 120, 121, 139
 marmoratus, 117, 120, 121
Synallaxidae, 148, 168
Synallaxis, 143, 149, 155, 168
 cinnamomea, 155
 gujanensis gujanensis, 143, 149, 155
Synarmadillo Dollfus, 490
Synentognathi, 115
Synognathidae, 115
Synhamitermes, 430
Syntermes, 107, 294, 297, 303, 313, 357-363
 dirus, 294, 359
 grandis, 294, 303, 313, 357
 parallelus Silvestri, 294, 303, 313, 361-363
 description, 361-363
 (Fig. 46), 362
 snyderi, sp. nov., 294, 303, 313, 358
 description, 358-359
 (Fig. 44), 358
 territus sp. nov., 303, 313, 359-361
 description, 359-361
 (Fig. 45), 360
Syrinx of tinamou, 215-219
 (Fig. 21), 216
 voice production, 217-219
Syrphidae, 97
Tabanidae, 46, 96
Tabanus mexicanus, 96
Tabassous uncinatus, 183
Tabernaemontana
 undulata Vahl, 39
Taboga Island, Panama, 296
Tachinidae, 98
Tachycineta albiventris, 151, 156
Tachyphonus, 145, 149, 157
 rufus, 149, 157
 surinamus surinamus, 145
Tachyphonus intercedens Berl., 145
Tamandua, 71, 177
Tanager, 45, 47, 49, 50, 145, 146, 172
 Blue, 145, (Fig. 15), 172
 Bright Colored, 47
 Callistes, 47, 49, 172
 Chestnut-headed, 145
 Chlorophanes, 47
 Eastern alm, 145
 Fulvus-crested, 145
 Golden-crested, 145
 Palm, 50, 172
 Silver-beaked, 45, 145, 172
 Summer, 146
 Yellow-bellied, 145

- Tanagra, 145, 157, 172
 cayennensis, 157
 violacea violacea, 145, 157
Tanagrella velia, 157
Tanagridae, 148, 172
Tanaiidae, 461, 469-470
Tangara, 49, 145, 157, 172
 gyrola (Linné), 145, 157
 mexicana mexicana (Linné), 49, 145, 157
Tangaridae, 148
Tantilla, 136
Tanypezidae, 98
 Tapeworm, 214
Tapera, 165
Tapir, 173, 185
Tapiridae, 185
Tapirira guianensis Aubl., 35, 39
Tapirus, 185
Tarantulidae, 61, 66
Tardigrada, 63
Tatoua, 183
Tatu, 183
Tauroneero, 35
Tayassu pecari beebei, 185
Tayassuidae, 185
Tayra barbara, 47, 179
 Tee-Van, Mr. John, 293, 342, 372, 378, 383
Teiidae, 128, 134
Telemona spiniger sp. nov., 257, 275
 (Pl. III, fig. 3), 246
Telephorides, 91
Telotha henselii (von Martens), 461, 468,
 478-481
 description, 478-481
 (Plate XII, figs. 19-23 incl.), 479
 Temperature,
 Kartabo, British Guiana, 12
 water, of, 22
Tenebrionidae, 92
Tenipa americana Linné, 35
Tenthredinidae, 100
Terenura spodiopila, 155
Termes, 294, 298, 299, 326, 340, 344, 347,
 348, 367, 379, 435, 444
 albidus, 367
 capensis, 298
 decumanus, 294
 fatalis, 298
 marabitanas, 344
 morio, 294, 379
 nasutus, 347
 saltans, 435
 tenuis, 340
 trispinosus, 444
 Termite, 47, 48, 49, 71-72, 80, 90, 107
 Termites, The, of Kartabo, Bartica District,
 British Guiana,
 by Alfred Edwards Emerson, 291-459
 (Figs. 24-94 incl.), 317, 319, 321, 322,
 325, 327, 328, 330, 333, 334, 337, 338,
 341, 343, 346, 348, 351, 353, 355, 357,
 358, 360, 362, 363, 366, 368, 370, 372,
 373, 374, 377, 380, 384, 386, 387, 389,
 391, 392, 395, 396, 397, 401, 403, 404,
 406, 408, 409, 411, 413, 414, 417, 418,
 422, 425, 426, 429, 431, 433, 435, 438,
 441, 443, 444, 446, 448, 450, 451, 454
 acknowledgements, 293
 bibliography, 455-459
 classification, 298-299
 comparative statistics, 294-295
 description of species, 316-455
 distribution, 297
 historical summary, 294
 introduction, 291-294
 key: British Guiana Termites, 304-312
 list of species, 312-315
 localities, 292, 295, 296
 measurements, 299-301
 new specific and subgeneric names, 299
 species recorded; British Guiana, 301-
 304
 statistical summary, 295
 terms defined, 299-301
 types, 293-294
 use of key, 304-305
Termitidae, 313-314, 357-455
 Terms, of Occurrence,
 defined, 43
 Tern, 142, 160
 Common, 142
 Great-billed, 142
Testudinata, 126
Testudinidae, 126
Testudo denticulata, 126
Tetradontidae, 116
Tetragonopterus chalceus, 119
Tetrao variegatus, 195
Tettigides, 67
Tettigoniidae, 68
Thalurania, 47, 154
 furcata fissilis, 154
Thamnomanes glaucus, 47, 143, 155
Thamnophilus, 63, 151
 incertus, 151
Thecadactylus, 129, 130, 131, 132, 133
Therevidae, 96
Therinia, 82
Theristicus caudatus, 149, 153, 162
 Thompson, Prof. Caroline B., 398
Thoracostraca, 59
Thrasaetus harpyia, 152, 163
Thraupis, 50, 145, 157, 172
 episcopus episcopus (Linné), 145, 157
 (Fig. 15), 172
 palmarum melanoptera (Sclater), 145,
 157
 Thrips, 78
Thrombidium (bête rouge), 200, 214
 Thrush, 49, 144, 171
 Sabian, 144
 White-throated, 49
Thryothorus griseigula, 148
 Thurn, im, 192
Thysanoptera, 78
Thysanura, 65-66
 Ticks, 62-63, 200, 214
 Tiger-beetles, 89
 Tiger Lilly, 41
Tigrisoma lineatum, 149, 162
Tinamidae, 158
Tinamiformes, 147, 158
 Tinamou, The Variegated (*Crypturus varie-*
 gatus), by William Beebe, 195-227
 (Plates A, B; Figs. 18-22 incl.), 196,
 198, 202, 206, 211, 216, 225
 abundance, 195
 breeding, 201-202, 205-207, 220-221
 calls, 197-199, 202
 chick, 220-227, (Fig. 22), 225
 description, type, 195
 egg, 205-206
 enemies, 199
 external characters, 207-214
 feathers, 208-212, 222-223
 food, 200
 internal characters, 214-220
 syrinx, 215-219
 moult, 210
 nesting, 204
 (Fig. 19), 206
 parasites, 214
 plumage, 209-214, 222-223
 scalation, 213, 223
 syrinx, 215-219
 (Fig. 21), 216
 voice production, 217-219
 Tinamou, 51, 141
 Guiana Great, 141
 Variegated, 51, 141, 195-227

- Tinamus*, 141, 153, 158, 201, 207
 major major (Gmel.), 141, 153, 195, 199
 egg of, 207
Tipulidae, 95
Tityra, Black-tailed, 144
Tityra cayana (Linné), 144, 156, 170
 Tobacco, British Guiana, 187
Todirostrum, 144, 156
 cinereum, 156
 maculatum maculatum, 144, 156
Tolania scutata Stal., 259
 Tollenar, Peter, 190
Tomaspis ruber, 49, 77
Tomeurus, 53, 58, 115, 117, 118
 gracilis, 117, 118
Tontanea, 29
 Topaz, British Guiana, 17
Topaza pella, 154
 Torchwood, 40
 Tortoise, 126
 Toucan, 46, 49, 142, 148, 166
 sulphur and White-Breasted, 46, 49, 142
Touit purpurata (Gmel.), 142, 163
 Tourmaline, British Guiana, 17
 Tracheata, 63-107
Trachycorystes obscurus, 120
Tragopa, 247-249, 268, 269, 273, 277, 282, 284
 cimicoides (Fabr.) and Fairm., 247, 268, 273, 277, 282, 284
 (Pi. VI, fig. 6), 264
 guianae sp. nov., 247-248, 269, 282
 (Pi. III, fig. 2), 246
 occulta sp. nov., 248
 (Pi. III, fig. 1), 246
 partita, 268, 270
 scutellaris Buckt., 248, 282
 tripartita Fairm., 248, 269, 282
 Trees, British Guiana, 30-35
 Tree of Life, 39
 Tree boa, 137
 (Fig. 13), 137
 Tree-creeper bird, 148
 Tree Toad, 122
 Trematodes, 55
Trichechidae, 185
Trichechus, 185
 Trichoptera, 80
Tridactylides, 69
Trigona, 101
Trigonidiides, 70
Tripsurus rubifrons, 50
Triquetra nigrofasciatus Buckt., 284
 Trochelmintes, Kartabo, British Guiana, 43, 56
Trochilidae, 164-165
Troglodytes, 144, 156, 170
 clarus, 156
 musculus, 144
Troglodytidae, 147, 170
Trogon, 45, 142, 154
 melanurus, 154
 rufus, 154
 s. strigilatus, 45, 142, 154
 violaceus, 154
Trogon, 45, 49, 72, 142, 165
 Black-throated, 49, 142
 Black-tailed, 142
 Green, 45, 142
 Southern, 142
Trogones, 165
Trogonidae, 165
Trogoniformes, 147
Trogonurus, 49, 142, 154
 collaris, 154
 curucui, 49, 142
Trombidiidae, 63
 Tropical Research Station of the New York Zoological Society, 4, 6, 18, 196, 198
 Tropical Wild Life, 197
Tropidaspis, 259-261, 272, 282, 285
 carinata (Fabr.), 259, 267, 272, 282, 285
 (Pi. V, fig. 4), 260
 cornuta sp. nov., 261, 285
 (Pi. V, figs. 1, 1a), 260
 minor sp. nov., 259-261, 285
 (Pi. V, fig. 3), 260
Tropidocyta, 236-239, 267, 269, 275, 277, 280, 281, 282, 283
 albipes, Funk, 237
 bulbosa sp. nov., 236, 277, 280, 281
 (Pi. I, fig. 2; Pi. II, fig. 3; Pi. VI, fig. 8), 234, 238, 264
 gibbosa (de Geer), 237, 267, 269, 282
 (Pi. I, fig. 1), 234
 neglecta sp. nov., 237, 275
 (Pi. II, fig. 4), 238
 pruinosa sp. nov., 237-239
 (Pi. I, fig. 3; Pi. II, fig. 5), 234, 238
Tropidurus, 129
 Trumpter, hump-backed, 160-161
Trypetidae, 48, 98
Trypoxilonidae, 104
 Trysil Trees, 30, 40
Tryxalides, 46, 50, 67
Tuberculitermes, 432
 Tuiche River, Bolivia, 296
 Tukeit, B. G., 296
 Tumatumari, B. G., 296
 Tumble-bugs, 89
Tupinambis, 129, 130, 131, 132, 134
 Turbellaria, 54-55
Turdidae, 147, 148, 171
Turdus phaeopygus, 49, 171
 Turtles, 126
Tylosaurus, 115
Typhlonectes, 114
Typhlopidae, 135, 138
Typhlops, 135, 136, 138
Tyrannidae, 147, 148, 169
Tyranniscus acer, 156
Tyrannus melancholicus satrapa, 144, 156, 169
 Tyrant, Helmeted Pygmy, 144
Umbonia spinosa (Fabr.) and Fairm., 243, 276, 284
 Union, St. Lucia, E. I., 296
 Unios, 58
Urania, 83
Uranidae, 81, 83
Urochroma, 48
Urodeles, British Guiana, 121
Urogalba d. dea, 154
Urubitinga urubitinga, 152
Utricularias, 25
 Vampire bats, 176
Vampyrus, 178
 Van Der Heyden, 189, 191
 Van Gravesand, Governor Storm, 190
 Van Name, Willard G.,
 The Isopods of Kartabo, Bartica District, British Guiana, 461-503
 for paged outline see 'Isopods'
Vandellia difusa Linné, 25
Vanduzea testudinea sp. nov., 251, 269, 277, 282
 (Pi. III, fig. 5), 246
Vavasouria, 170
Velocitermes, 297, see also *Nasutitermes*
 Velvet Leaf, 37
Veronicella, 58
 Vertebrates, Kartabo, British Guiana, 107-186
 Vervain, 37
Vespidae, 103-104
Vireo, 171
Vireolanius, 171
Vireonidae, 147, 171
Vismia, 40, 268, 269
 ferruginea H.B.K., 40, 268, 269

- guianensis* Pers., 40
Vochysia tetraphylla DC., 31
 Voice production in birds, 217-219
Volatinia splendens, 157
Volucella, 45, 48, 49
Volvox, 53
Vorticella, 52, 53
 Vryheid, British Guiana, 189
 Vulture, 47, 49, 142, 163
 black, 163
 red-head, 163
 white-king, 163
 yellow-headed, 47, 49, 142, 163
 Waikey, 31, 41
 Walker, F., 294, 359, 459
 Walking Stick (insect), 50
 Wallaba tree, British Guiana, 21
 Wanasuru, 33
 Warble fly, 180
 Warbler, 144, 145, 146, 171
 Black-poll, 146
 Yellow, 144, 145, 171
 Wareemeah, 33, 39
 Warracabra, 160-161
 Wasmann, E., 340, 344, 459
 Wasp, 45, 46, 47, 49, 50, 66, 80, 99-107
 Blue Hunting, 45, 49
 Braconid Wasp, 49
 Chalcid, 47, 50
 Green-and-Black Chalcid, 46
 Water-bear, 63
 Water-thrush, Small-billed, 146
 Weasel, giant, 47, 179
 Weevils, 37, 46, 48, 88, 93
 Wenamu River, 296
 Westwood, J. O., 459
 Wheeler, Prof. William Morton, 105, 263, 273, 293, 381, 393
 White-plumed Sedge, 23
 Who-are-you bird, 148
 Woodbird, Guiana, 144
 Woodhewer, 50, 64, 71, 80, 143, 166
 Chestnut-rumped, 143
 Guiana Curve-billed, 143
 Guiana Spotted, 143
 Rufus-throated, 143
 Woodpecker, 45, 47, 48, 49, 50, 71, 143, 166
 Giant Lineated, 47
 Green Dwarf, 45
 Lineated, 143
 Red-fronted, 50
 Red-necked, 143
 Spix's Amazonian, 143
 Wren, 144, 148, 170
 Guiana House, 144, 148
 Quadrille, 170
Xenocara gymnorhynchus, 119
Xenodon, 55, 136, 138, 139
Xenopidae, 148, 168
Xenops genibarbis genibarbis, 143, 168
Xipholena punicea (Pallas), 144, 156, 170
Xiphorhynchus, 64, 143, 150, 155
 guttatus sororius, 143, 155
 pardalotus (Vieill.), 143, 150
Xylocopa, 47
Xylocopidae, 102
Xyris tenella Kunth, 25
 Yellowlegs, 146, 160
 Greater, 146
 Lesser, 146
 Zircon, British Guiana, 16
 Zoraptera, 72
 Zygoptera, 74

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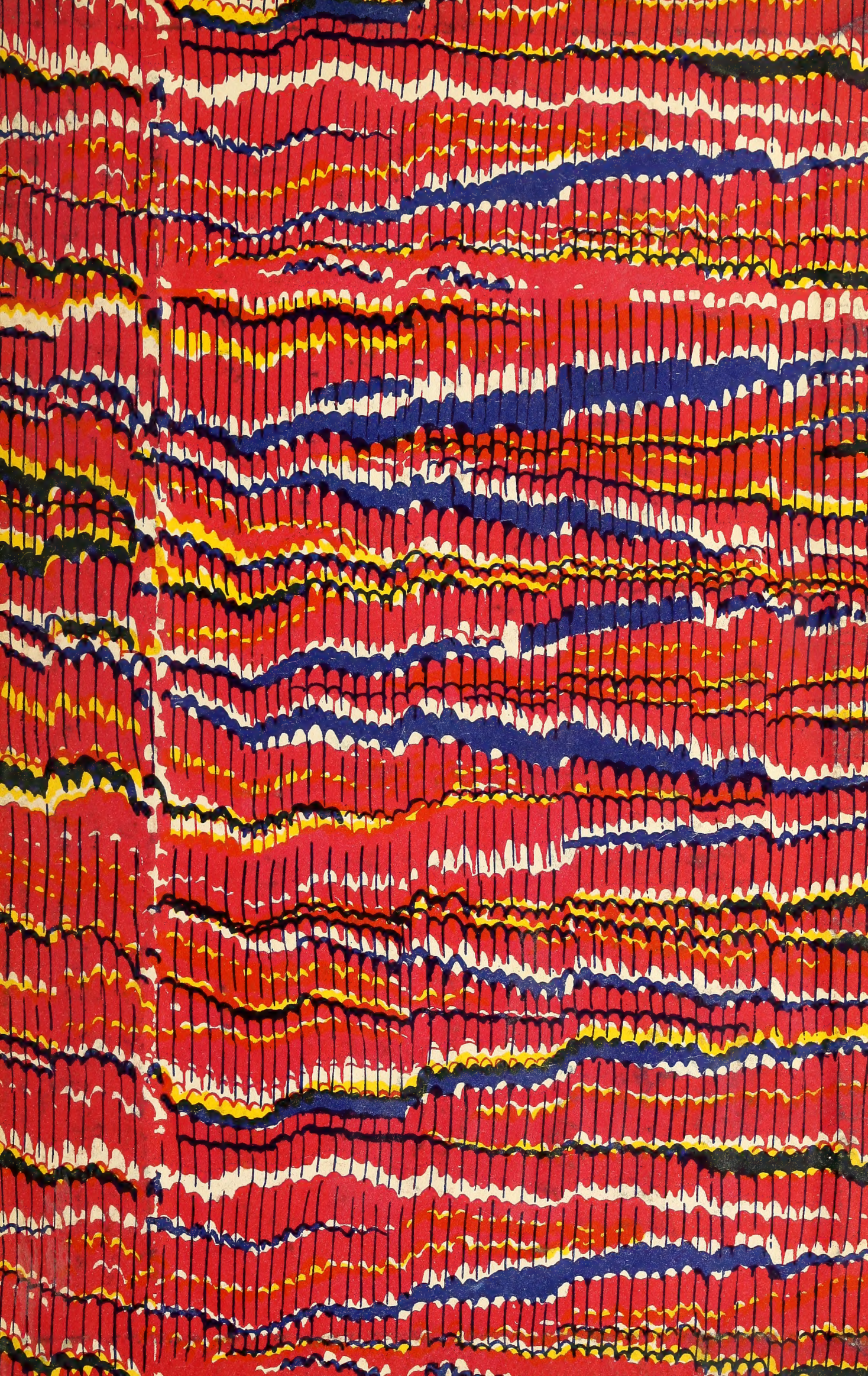
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